Canada's Nuclear Regulator

CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2010

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September 2011

Canadian Nuclear Safety Commission
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Canada

CNSC staff integrated safety assessment of Canadian nuclear power plants for 2010

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Cover images: Canadian Nuclear Power Plants
From left to right:
Bruce A and Bruce B Nuclear Generating Stations (Tiverton, Ontario)
Darlington Nuclear Generating Station (Bowmanville, Ontario)
Gentilly-2 Nuclear Generating Station (Becancour, Quebec)
Pickering A and Pickering B Nuclear Generating Stations (Pickering, Ontario)
Point Lepreau Nuclear Generating Station (Point Lepreau, New Brunswick)

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Foreword

The *CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2010* (NPP Report) summarizes the Canadian Nuclear Safety Commission (CNSC) staff's assessment of the Canadian nuclear power industry's safety performance during 2010 and details the progress of compliance and regulatory issues up to April 2011.

The 2010 NPP Report also summarizes the actions taken by NPP licensees and CNSC staff to review initial lessons learned from the earthquake and tsunami in Japan with the objective of confirming that the overall safety case of Canadian NPPs remains strong. Specifically, it was demonstrated that they have effective redundant safety systems to withstand external events, as well as adequate procedures and qualified staff available, at all times, to respond to such events.

A detailed report on licensee actions planned or taken as a result of lessons learned from the events in Japan will be included in next year's NPP Report.

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Executive Summary

This report, entitled *CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2010* (2010 NPP Report), summarizes the Canadian Nuclear Safety Commission (CNSC) staff's assessment of the Canadian nuclear power industry's safety performance during 2010 and details the progress of compliance and regulatory issues up to April 2011.

The 2010 NPP Report has undergone changes made necessary by the introduction of new safety and control areas (SCAs). The 14 SCAs, comprising 69 specific areas, were introduced and assessed for safety performance in the NPP Report.

The report consists of two major parts. Part 1 provides the assessment of the safety performance for the nuclear power industry as a whole and for each specific station, for the entire 2010 calendar year. Part 2 provides detailed information on licensing and other regulatory issues pertaining to each specific station (it covers the period from January 2010 to April 2011, thereby permitting a more recent view of issues at each of the NPPs).

Overall performance highlights

As a result of the assessment of inspection findings and desktop reviews, and reviews of events and performance indicators, CNSC staff conclude that the licensed NPPs in Canada operated safely during 2010. This conclusion is based on the observations that:

- There were no serious process failures at any NPP.
- No members of the public received a radiation dose in excess of the regulatory limits.
- No workers were confirmed to receive a radiation dose in excess of the regulatory limits.
- The severity of non-radiological injuries to workers was minimal.
- All environmental emissions from the stations were below regulatory limits.
- Licensees complied with their licence conditions concerning Canada's international obligations for the peaceful use of nuclear energy.

The NPP Report includes a rating for each SCA (except security, which is provided in a separate, classified report) and an integrated plant rating for each NPP. The integrated plant rating is a general measure of the overall acceptability of the performance of the entire set of applicable SCAs and specific areas for each NPP, as measured against the relevant requirements and expectations.

The CNSC's evaluation of the SCAs at each NPP confirmed, at a more detailed level, that the licensees' provision of measures to protect health, safety and the environment and to help respect Canada's international obligations met the CNSC's performance expectations.

The 2010 ratings for the SCAs and the integrated plant ratings are presented in Table 1 for all NPPs, along with the industry averages. The rating categories are "fully satisfactory" (FS), "satisfactory" (SA), "below expectations" (BE) and "unacceptable" (UA). Appendix B provides a full explanation of the rating categories.

Table 1: Canadian NPP Safety Performance Ratings for 2010

Safety and Control Area	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau	Industry Average
Management system	SA	SA	SA	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA	SA	SA	SA
Operating performance	SA	SA	FS	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA	SA	SA	SA
Fitness for service	SA	SA	FS	SA	SA	SA	SA	SA
Radiation protection	BE	SA	FS	SA	SA	SA	SA	SA
Conventional heath and safety	FS	FS	FS	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA	SA	BE	SA
Integrated Plant Rating	SA	SA	FS	SA	SA	SA	SA	SA
Waste management*	SA	SA	SA	SA	SA	SA	SA	SA
Security**	**Prescribed. See CMD 11-M46.A for this rating.**							
Safeguards**	SA	SA	SA	SA	SA	SA	SA	SA
Packaging and transport*	SA	SA	SA	SA	SA	SA	SA	SA

* Waste management and packaging and transport were excluded from the integrated plant rating as not all NPPs have operating licences in the new format with a Licence Conditions Handbook that utilizes the new SCA structure.

** Security and safeguards were excluded from the integrated plant rating, recognizing that these areas correspond to important elements of CNSC's mandate that complement — but are separate from — the mandate to protect health, safety, and the environment.

The integrated plant ratings in 2010 were "fully satisfactory" for Darlington and "satisfactory" for the remaining stations. This represents a decrease from 2009 where three stations received a "fully satisfactory" integrated plant rating. The reasons for this difference are the change in the defining elements of the integrated plant rating for 2010 and the use of the SCA framework in place of the former safety areas and programs.

SCA ratings for the stations ranged from "below expectations" to "fully satisfactory" in 2010. This also represents a decrease from 2009 where no station had a "below expectations" in safety area ratings. However, for the 2010 "below expectations" ratings, in radiation protection for Bruce A and in emergency management and fire protection for Point Lepreau, CNSC staff have determined that the licensees are taking appropriate actions to address the relevant issues in these areas and is monitoring the effectiveness of these actions.

Performance highlights of each NPP

Bruce A and B

The 2010 integrated plant ratings for Bruce A and B were both "satisfactory," representing a decrease from 2009 when both received a "fully satisfactory" rating. The change is due to the higher assessments in 2009 for operating performance and emergency preparedness (now referred to as emergency management and fire protection) together with the lower radiation protection assessment for Bruce A in 2010.

The majority of SCAs for both NPPs received "satisfactory" ratings and the conventional health and safety SCA was assessed as "fully satisfactory". However, the radiation protection SCA for Bruce A was rated as "below expectations". The primary reason for this was due to an unforeseen alpha contamination incident that occurred at Unit 1 in November 2009. Three workers received radiation doses between 5 and 10 milliSieverts (mSv); however, no worker received a dose in excess of the annual regulatory limit (i.e., 50 mSv/year and 100 mSv/5-year dosimetry period). Bruce Power has implemented the appropriate corrective actions in response to this incident.

Darlington

The 2010 integrated plant rating for Darlington remained "fully satisfactory", with no change from 2009.

The operating performance, fitness for service, radiation protection and conventional health and safety SCAs were assessed to be "fully satisfactory". Furthermore, Darlington safely conducted an outage of its tritium removal facility in accordance with governance procedures.

Pickering A and B

The 2010 integrated plant ratings for Pickering A and B were both "satisfactory", with no change from 2009 when both stations were rated as "satisfactory".

All the SCA ratings were "satisfactory". In the environmental protection area, Ontario Power Generation (OPG) has taken measures to reduce the fish mortality at both stations. A once-in-a-decade vacuum building outage (VBO) was successfully completed safely and on time. However, there were a number of issues related to the VBO, such as, for example, missing anchor bolts for the emergency service water piping that the licensee is addressing.

Gentilly-2

The 2010 integrated plant rating for Gentilly-2 was "satisfactory", with no change from 2009.

All SCAs were rated "satisfactory". Gentilly-2 conducted an inspection of its feeder pipes during the spring 2010 shutdown and found no flaws in the 421 pipes inspected. While the Gentilly-2 fire protection program is satisfactory and does not constitute a risk to workers, the public, station safety and the environment, CNSC staff found that this

program is no longer up-to-date and must be revised to meet the requirements of Canadian Standards Association (CSA) standard N293-07. This will be done according to the transition plan described in the Licence Conditions Handbook (LCH) and scheduled to be implemented by the end of 2012.

Point Lepreau

The integrated plant rating in 2010 for Point Lepreau was "satisfactory". This is the same integrated plant rating received by the licensee in 2009. In addition, the majority of the SCAs were rated as "satisfactory" in 2010 for Point Lepreau. However, the performance for the emergency management and fire protection SCA was "below expectations". This was based on deficiencies in the area of fire brigade and emergency response team drills. The licensee is working towards resolving these issues.

In 2010, refurbishment activities continued at Point Lepreau. In view of the reactor restart planned for 2012, areas not evaluated or rated in 2009 as a result of the refurbishment activities have been assessed in 2010.

Lessons learned from the Japanese earthquake and tsunami

In response to the events in Japan in March 2011, CNSC staff sent a written request under section 12(2) of the *General Nuclear Safety and Control Regulations* (GNSCR) to licensees of major nuclear facilities in Canada to complete specific actions at their facilities, including:

- review initial lessons learned from the earthquake in Japan and re-examine the safety cases of NPPs, in particular the underlying defence-in-depth concept with focus on:
  - external hazards such as seismic, flooding, fire and extreme weather events
  - measures for prevention and mitigation of severe accidents
  - emergency preparedness
- report on implementation plans for short-term and long-term measures to address any significant gaps

All NPP licensees provided the requisite initial response, identifying their proposed plan and schedule to meet the CNSC's request. The licensees have concluded that the overall safety case remains strong. Furthermore, the CNSC has performed a series of walk-downs at each station to confirm this.

Introduction

The CNSC publishes an annual report that summarizes the CNSC staff's assessment of the safety performance of Canada's NPPs. This assessment is aligned with the legal requirements of the *Nuclear Safety and Control Act* (NSCA) and its associated Regulations, as well as the conditions of the operating licences and applicable standards and regulatory documents. The *CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2010* (NPP Report) assesses the safety performance of the nuclear power industry as a whole, as well as the performance of each NPP.

Licensees are required to implement programs that make adequate provisions for the protection of the environment, the health and safety of persons, the maintenance of national security and the measures required to implement Canada's international obligations. This means that licensees are responsible for operating their plants safely.

The evaluations in this report are supported by information obtained through CNSC staff inspections, general surveillance, document assessments, desktop reviews, event reviews and performance indicator data.

What is new for 2010?

During 2010, CNSC continued to make improvements in its operations through the introduction of changes to business practices supporting its regulatory functions. These changes have resulted in the need to revise the contents and the format of the 2010 NPP Report, as follows:

Safety and control areas

The new safety and control area (SCA) framework was introduced in 2010 for use in all operating licences and provides a common set of safety and control terms that are applicable across the entire CNSC. The SCAs are presented in a comprehensive framework consisting of 14 SCAs that are grouped into three primary functional areas (management, facility and equipment, and core control processes). This new framework replaces the previously used safety areas and programs.

Table 2 compares the previous safety areas to the new SCAs: three safety areas were split to form six SCAs, one safety program moved to another safety area to create a new combined SCA, and two new SCAs were introduced. The overall result is that nine safety areas have been replaced by 14 SCAs. The safety performance of the nuclear power industry and the specific stations will be determined and expressed in terms of the SCAs.

Table 2: Comparison of 2009 Safety Areas and the 2010 Safety and Control Areas

2009 Safety Area	Corresponding 2010 Safety and Control Area
Operating performance	Operating performance Conventional health and safety
Performance assurance	Management system Human performance management
Design and analysis	Physical design Safety analysis
Equipment fitness for service	Fitness for service
Emergency preparedness	Emergency management and fire protection*
Environmental protection	Environmental protection
Radiation protection	Radiation protection
Site security	Security
Safeguards	Safeguards
	Waste management
	Packaging and transport

* "Fire protection" migrated from the 2009 "design and analysis" safety area to the 2010 "emergency management and fire protection" SCA.

The 14 SCAs are further divided into 69 specific areas that define the elements of the SCA, as given in Appendix A.

Format

As part of the NPP licence reform initiative, the CNSC modified annual reporting to the Commission and to the public on NPP safety performance. Consequently, the NPP Report now provides information not only on industry safety performance, but also on the status of the regulatory obligations from licensing decisions, as well as other licensing and regulatory issues.

To accommodate this dual purpose, the NPP Report is divided into two parts. Part 1 is entitled "Safety Performance" and is similar to previous NPP Reports in that it provides CNSC staff's assessment of the safety performance of Canadian NPPs, as well as the industry performance as a whole. The information presented in Part 1 covers the 2010 calendar year. Part 1 is further divided into section IA, "industry performance and developments" and section IB, "Station performance".

Part 2 is entitled "Regulatory Developments and Issues" and provides detailed information on licensing and other regulatory issues including, as applicable:

- licensing
  - licence amendments
  - revisions to the LCH
  - progress made on licensing commitments
- updates on major projects and initiatives; and
- updates on significant regulatory issues, including the path forward for resolution of issues

Part 2 covers the somewhat extended period of January 2010 to April 2011, allowing CNSC staff to keep Commission members and the public informed of more recent developments on regulatory issues. Where necessary, significant issues that affect the safety performance ratings in Part 1 are updated in greater detail in Part 2, including recent actions by both the licensee and CNSC staff.

Canada's NPP industry

There are seven licensed nuclear power plant (NPP) in Canada: Bruce A, Bruce B, Darlington, Pickering A, Pickering B, Gentilly-2 and Point Lepreau. They are located at five sites in three provinces, as shown in Figure 1, and are operated by four different licensees. These NPP sites range in size from one to four power reactors, all of which are of the CANDU (CANada Deuterium Uranium) design. This design was developed by the Canadian crown corporation Atomic Energy of Canada Limited (AECL) and CANDU reactors have been sold and are operating worldwide.

Figure 1: Locations of Power Reactor Sites in Canada

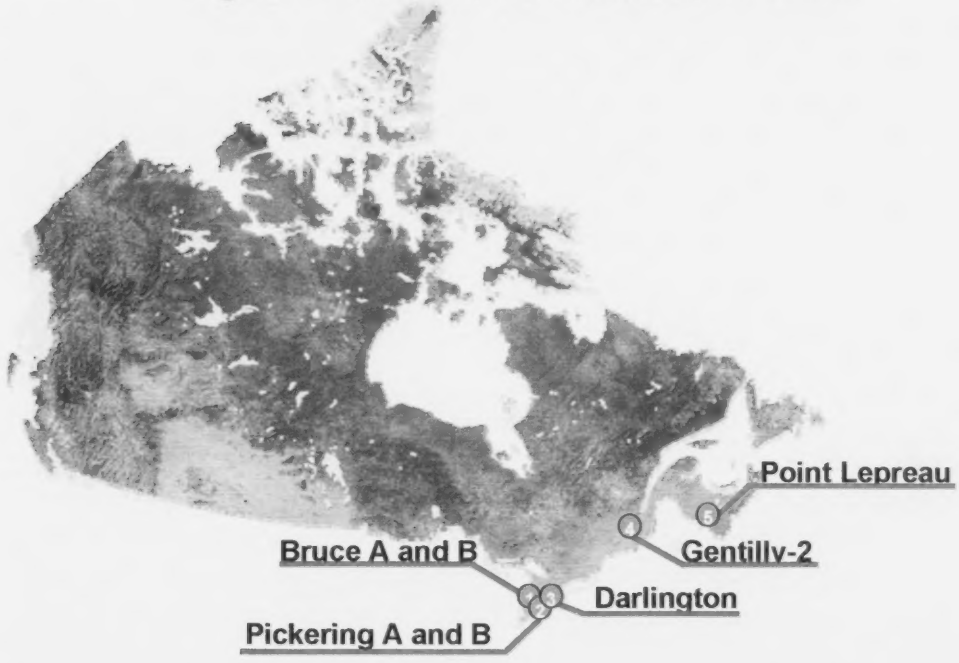


Table 3 gives the generating capacity of the reactors at each NPP site, their initial start-up date, the names of the licence holders, and the expiry dates of the operating licence. Seventeen reactor units were operational in 2010. Pickering A Units 2 and 3 are in laid-up, non-operating state. They were defueled in 2008, and will remain laid up until the eventual decommissioning of the Pickering site. Bruce A Units 1 and 2 and Point Lepreau were not operational in 2010, as they are undergoing refurbishment for life extension. Three stations received renewed operating licences during the period of January 2010 to April 2011: Pickering A, Gentilly-2 and Point Lepreau.

Table 3: Plant Data for NPP Sites in Canada

Plant Data							
Plant	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau
Licensee	Bruce Power	Bruce Power	Ontario Power Generation	Ontario Power Generation	Ontario Power Generation	Hydro-Québec	New Brunswick Power Nuclear
Reactor Units	4	4	4	*2	4	1	1
Gross Electrical Capacity/ Reactor (MW)	904	915	935	542	540	675	680
Start-Up	1977	1984	1989	1971	1982	1983	1982
Licence Expiry	2014/10/31	2014/10/31	2013/02/28	2013/06/30	2013/06/30	** 2011/06/30	2012/06/30

* Two additional units are currently in a defueled laid-up state.

** A Commission hearing to renew the licence to June 30, 2016 was held on April 13 and 14, 2011.

Safety performance assessment

The NPP Report presents safety performance ratings for each SCA at each NPP against relevant requirements and expectations. The ratings were determined through using the findings made throughout the year during inspections, as well as the review of desktop analyses, events and performance indicators. In generating the performance ratings, CNSC staff considered over 2,600 findings. The findings were categorized into appropriate SCAs and assessed against a set of performance objectives that the CNSC developed for each SCA.

The assessment presented in the NPP Report includes an integrated plant rating for each NPP. The integrated plant rating is a general measure of the overall acceptability of the performance of the entire set of SCAs for each NPP. The integrated plant rating is determined by combining the ratings of the individual safety and control areas, in an appropriate manner, to account for the relative importance of each SCA to the overall plant safety performance. However, the SCAs of security and safeguards were excluded from the integrated plant rating because these areas correspond to important elements of CNSC's mandate that complement — but are separate from — the mandate to protect health, safety, and the environment. Waste management and packaging and transport were also excluded from the overall plant ratings, since not all NPPs have operating licences in the new format with a LCH that incorporates the new SCA structure. For 2010, only those SCAs common to all operating licences were included in the integrated plant ratings.

The rating for the security SCA is not reported publicly, as it contains prescribed information, but is addressed in a separate, confidential report presented to the Commission in a non-public, confidential manner.

It is important to note that the introduction of the new SCAs in 2010 allows for only a partial comparison of the 2009 ratings with the 2010 ratings for the different safety program areas. This is because some of the previous nine safety areas were reformatted into new SCAs and a direct comparison is not possible. Two new SCAs, waste management and packaging and transport, were also introduced. The result is that there is not always a direct comparison of the 2009 and the 2010 performance ratings in this report, but where a comparison can be made, and is relevant, then it is made in the particular station section.

CNSC regulatory efforts

As Canada's nuclear regulator, the CNSC is responsible for, among other activities, regulating the operation of NPPs by issuing licences and ensuring compliance with these licences through verification, enforcement and reporting. In addition, the CNSC does many inspections, assessments, reviews and evaluations of licensee programs, processes and safety performance throughout the year. This work varies in complexity and length and consumes the efforts of approximately 226 CNSC staff within the Power Reactor Regulatory Program. This total effort includes approximately 38 CNSC employees

permanently located at the seven stations who perform on-site inspections, monitor safety performance and provide regulatory support.

The CNSC business practices and staff are kept current with technological developments and improvements. For example, a new Inspector Training and Qualification Program was introduced in 2009 and this program continued to grow in terms of application and participants during 2010. The program introduces a consistent set of training and qualification requirements in order to ensure a high level of ability and knowledge among inspectors throughout the CNSC. In addition, during 2010, several CNSC inspectors visited the US NRC and two US NPPs for the purpose of benchmarking best practices in the conduct of main control room compliance inspections.

Appendices

The 2010 NPP Report has six appendices:

- Appendix A provides the specific areas and the definitions and the performance objectives of the SCAs.
- Appendix B provides the definitions of the rating categories for the safety and control areas and integrated plant ratings ("fully satisfactory", "satisfactory", etc), and an explanation of the rating methodology.
- Appendix C is a glossary of specialized and technical terms used in the text.
- Appendix D defines the acronyms used in the report.
- Appendix E has been renamed "Research and Development Efforts in Support of NPP Regulation" and provides status updates for the CANDU safety issues, including the generic action items (GAIs) that were open in 2010.
- Appendix F provides worker doses at all Canadian NPPs in 2010, in addition to the five-year trend of annual collective doses to workers at each NPP.

Public consultation

For the 2010 NPP Report, as was initiated with the last NPP Report, stakeholders have been invited to comment on the report prior to its formal presentation to the Commission. This mechanism has been introduced as a systematic way to generate discussion on the overall safety performance of NPPs in Canada, and potentially identify areas where the NPP Report can improve to better serve the needs of stakeholders.

Part 1 – Safety Performance

Part 1 of this report presents CNSC staff's assessment of the safety performance of Canadian NPPs, as well as the industry performance as a whole. As part of this assessment, CNSC staff evaluate how well licensees' programs meet regulatory requirements and expectations and contribute to the overall health, safety and security of Canadians and the environment; in addition to meeting Canada's international commitments on the peaceful use of nuclear energy. The evaluations are based on findings made throughout the year during inspections, desktop reviews, and event reviews and are categorized according to the 14 SCAs.

A total of over 2,600 findings were analyzed by CNSC staff in the process for determining the SCA ratings. Of this total number of findings, over 99% were assessed as being either of positive, negligible or low safety significance meaning the finding was one that had an effective, insignificant or small negative impact on the assessment of the specific area. Therefore, the remaining less than 1% of the findings were the ones that either had a significant or major negative impact on the assessment of the specific areas.

The assessment of the safety performance of Canada's NPPs covers the entire 2010 calendar year.

1A – Industry performance and developments

This section presents the overall safety performance of the industry in each of the SCAs and highlights generic issues and observations.

The overall performance of the industry is determined by calculating an "industry average" rating for each SCA. The industry average is the mean performance rating of all seven stations and will allow for trending of industry performance in subsequent years.

CNSC performance indicators (PIs) are also included in this section to illustrate various trends. PIs are defined in Regulatory Document S-99, *Reporting Requirements for Operating Nuclear Power Plants*, and can be used to study an individual station's performance or the NPP industry's performance over time. Comparing station to station data in any particular year is difficult since many factors—such as the number of operating units, design, unit capacity, station governing documents, etc.—contribute to differences in PI data.

1A.1 Management system

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Management system	SA	SA	SA	SA	SA	SA	SA	SA

BA=Bruce A; BB=Bruce B; Darl=Darlington; PA=Pickering A; PB=Pickering B; G-2=Gentilly-2; PL=Point Lepreau

The management system SCA covers the framework which establishes the processes and programs required to ensure an organization achieves its safety objectives and continuously monitors its performance against these objectives and fosters a healthy safety culture. The industry average for this SCA was "satisfactory" in 2010.

Management system

The requirements for the management of safe operation for NPPs continue to transition from those of a quality assurance program in accordance with the CSA N286 Series of QA Standards (N286.0 through N286.6) to those of a management system as per CSA Standard N286-05 *Management System Requirements for Nuclear Power Plants.* The new requirements for a management system emphasize overall safe operations versus specific controls and requirements for safety-related systems and equipment. The implementation and performance of a management system is subject to the planning and the review by senior management. Both a quality assurance program and management system define those processes needed to operate a NPP safely and it is an expectation of the CNSC that these be implemented by the licensee.

For the management of safe operations, the current operating licences for Bruce Power and Ontario Power Generation (OPG) NPPs reference the applicable requirements as CSA Standard N286-05. The current operating licences for Hydro-Québec and

New Brunswick Power (NB Power) NPPs do not reference the requirements as those of CSA Standard N286-05; however, CNSC staff will recommend that the requirements of CSA Standard N286-05 shall be included upon renewal of these licences in 2011 for Hydro-Québec and 2012 for NB Power.

During this transition between versions of CSA N286, licensees are taking the opportunity to conduct a detailed review of their process documentation to ensure that it will comply with the new requirements. As updates are made to the documentation CNSC staff reviews a key set of those documents as part of the oversight to obtain the required assurance of safe operation.

During 2010, CNSC staff did not identify any deficiencies related to this transition between versions of CSA N286 that may have increased the risk to the safe operations of NPPs.

Monitoring and review of safety management performance

Data regarding management performance is collected by licensees and reports are generated and widely distributed to all levels of management. The reports provide data from established performance indicators against established goals for those indicators. Management reviews the reports to identify management process weaknesses allowing for improvements to be made.

During the reporting year, CNSC staff did not identify any deficiencies related to adequate monitoring and review of safety management performance that may have increased the risk to the safe operations of NPPs.

Safety issues

In 2007, the CNSC initiated a project to systematically re-assess the status of outstanding design and analysis safety issues for CANDU reactors. Initially a list of seventy-two safety issues was identified from IAEA TECDOC-1554 and other sources of information. Twenty of the issues were identified as issues of concern in Canada for which measures are in place to maintain safety margins, but further experiments and/or analyses were required to improve their understanding and to confirm the adequacy of the measures.

In 2008, a joint CNSC/industry Working Group (WG) was created to validate the risk informed decision making (RIDM) process, which was used to assess the relative risk importance of the safety issues, and to develop risk control measures for the remaining issues of concern in Canada. Revisions to the RIDM process and safety issue descriptions were completed by the end of 2008.

In 2009, the CNSC/industry RIDM WG updated the safety issues' risk evaluations and assessments, using the revised RIDM process and the most recent information on the various safety issues. This exercise led to the re-categorization of four safety issues to lower categories.

In 2010, industry took risk control measures and provided adequate information to the CNSC for resolving three of the safety issues. At the end of 2010, 13 pending resolution safety issues remained, 4 related to large loss of coolant accident (LLOCA), and 9 non-LLOCA related.

Industry has established a CANDU Owners Group (COG) joint project to address LLOCA safety issues. The activities of this industry working group are closely monitored by CNSC staff. The LLOCA analytical solution project execution plan was published in March 2010. This is a high-level plan in which major tasks and deadlines are identified. CNSC staff are satisfied with industry's progress with respect to LLOCA safety issues.

The CNSC and industry staff also held periodic discussions to resolve the non-LLOCA issues.

Generic action items

In 2010, the industry continued working towards resolution of generic action items (GAI) as part of an overall industry effort to address safety issues. A GAI is a safety issue that is common to more than one station and complex in nature. Seven GAIs were active in 2010; of those, three GAIs (94G02, "Impact of fuel bundle condition on reactor safety"; 95G02, "Pressure tube failure with consequential loss of moderator"; and 95G05, "Moderator temperature predictions") were closed. Brief descriptions of current GAIs and their expected closure dates are provided in Appendix E.

1A.2 Human performance management

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Human performance management	SA	SA	SA	SA	SA	SA	SA	SA

The human performance management SCA covers activities that enable effective human performance through the development and implementation of processes that ensure that licensees have sufficient staff in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties. The industry average rating for human performance management was "satisfactory" in 2010.

Examination and certification

In 2009, the Commission authorized NPP licensees to directly administer the initial certification examinations in accordance with CNSC requirements and guidelines, a function previously held by the CNSC. Commensurate with this regulatory change, CNSC staff implemented a transition compliance strategy to verify the licensees' certification examination programs and processes, while also pilot-testing CNSC compliance tools in preparation for finalizing baseline compliance activities. This transition strategy continued in 2010. Implementation of the baseline compliance strategy is forecast to begin in 2011.

A total of 16 written/oral-based certification examinations and 13 simulator-based certification examinations for shift personnel were administered by licensees in 2010. Additionally, three oral-based certification examinations for Senior Health Physicists (SHPs) were administered by CNSC staff.

In order to obtain a high level of confidence that persons presented for certification are competent to perform their duties, CNSC staff focused inspection activities on the performance-based certification examination. Eight inspections of initial simulator-based examinations administered by licensees were conducted under the new regulatory requirements. Licensees have taken corrective actions to address all the identified deficiencies. As a result, the overall certification examination program at each licensee remains satisfactory. A total of 57 initial certifications and 104 renewals of certification were issued by the CNSC in 2010.

In 2010, the overall success rate in initial certification examinations for the industry was 94% and the requalification pass rate was 94%.

Each licensee maintained an adequate number of certified Reactor Operators (ROs), Unit 0 Operators (U0Os), Control Room Shift Supervisors (CRSSs) and Plant Shift Supervisors (PSSs). The number of certified staff for each NPP as well as the minimum number of certified staff required by each licensee's minimum shift complement is given in Table 4.

Table 4: Numbers of Certified Staff at NPPs as of the end of 2010

		RO	U0O	CRSS and PSS	Total (not including SHP)	Actual /Min (%)	SHP	Total Certified Staff
Bruce A	Minimum	15	10	10	35	234		
	Actual	32	28	22	82		6	88
Bruce B	Minimum	30	10	10	50	184		
	Actual	54	16	22	92		4	96
Darlington	Minimum	30	10	10	50	190		
	Actual	52	20	23	95		2	97
Gentilly-2	Minimum	6		6	12	225		
	Actual	14		13	27		4	31
Pickering A	Minimum	20		10	30	237		
	Actual	50		21	71		4	75
Pickering B	Minimum	30		10	40	190		
	Actual	58		18	76		4	80
Point Lepreau	Minimum	6		6	12	192		
	Actual	13		10	23		2	25
Industry Total	Minimum	137	40	62	229	203		
	Actual	273	64	129	466		26	492

Note: Darkened cells indicate positions that do not exist at the station or for which there are no minimum requirements.

Note that the SHP position is not subject to the licensee's minimum shift complement and therefore nothing is shown in the applicable rows of Table 4. Also note that since there are no U0O certified positions at Gentilly-2, Pickering A, Pickering B or Point Lepreau, the U0O cells show nothing for these plants in Table 4.

Analysis of Table 4 shows that the individual stations have from 184 to 237% of their minimum required number of certified staff, while the industry as a whole has over twice the minimum number of certified staff required by the operating licences. This analysis does not include SHPs for which there is no minimum required number. There were, as of the end of 2010, a total of 492 certified staff employed by the Canadian nuclear power industry.

1A.3 Operating performance

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Operating performance	SA	SA	FS	SA	SA	SA	SA	SA

The operating performance SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance. The industry average for operating performance in 2010 was "satisfactory".

There were no serious process failures at Canadian NPPs during 2010.

CNSC operations inspections in 2010 found that licensees complied with CNSC requirements, licensee procedures, and other relevant documents. Licensees met CNSC expectations for outage execution and outage safety and work management. The licensees also met CNSC expectations for outage management and safety and adequacy of procedures.

The licensees successfully conducted planned outages during the year of reactor units. Pickering conducted a once-in-a-decade vacuum building outage (VBO) and Darlington conducted an outage of its tritium removal facility. Overall, outages were conducted safely and in accordance with station procedures.

The Point Lepreau NPP remained shut down as its refurbishment outage continued. The shutdown continued throughout the year to permit retubing of the reactor as well as the completion of other system upgrades.

Unplanned outages at industry NPPs during the year were for a number of reasons, including equipment unavailability, overcurrent protection trip and maintaining the neutron overpower (NOP) margin for fuelling. Plant staff correctly responded to the unplanned outages and the outages posed little increased risk to plant operations.

The "number of unplanned transients" performance indicator (PI) denotes the unplanned reactor power transients due to all sources while the reactor was not in a guaranteed shutdown state (GSS). Unexpected power reductions may indicate problems within the plant and place unnecessary strain on systems. This indicator, illustrated in Table 5, shows the number of manual and automatic power reductions from actuation of the shutdown, stepback or setback system. Many of the unplanned transients experienced by industry NPPs in 2010 were setbacks, which typically pose little increased risk to plant operations. In 2010, there was an industry average of 12,900 hours between reactor trips (calculation based on 17 operating units). The international performance target is one reactor trip per 7,000 hours of operation, so this shows that Canadian NPPs are maintaining their number of reactor trips at levels below the international target. All transients were controlled properly and power reduction was automatically initiated by the reactor control systems.

Table 5: Number of Unplanned Transients for 2010

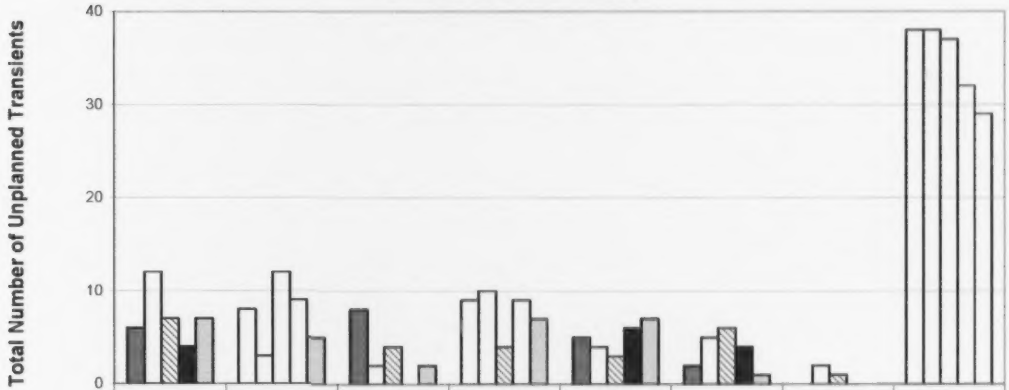
Station	Number of Hours of Operation	Unplanned Transients at Stations in 2010			
		Trips	Stepbacks	Setbacks	Total
Bruce A	15,144	1	1	5	7
Bruce B	33,102	1	3	1	5
Darlington	31,102	1	0	1	2
Pickering A	11,411	6	0	1	7
Pickering B	32,083	1	1	5	7
Gentilly-2	6,295	0	1	0	1
Point Lepreau*	n/a	n/a	n/a	n/a	n/a
Industry Total	129,137	10	6	13	29

* Reactor in defueled core state, due to refurbishment

Figure 2 shows the individual station and industry trend in terms of transients for the past five years. Industry-wide the total number of transients is lower in 2010 than in previous years but for three stations the values have increased slightly.

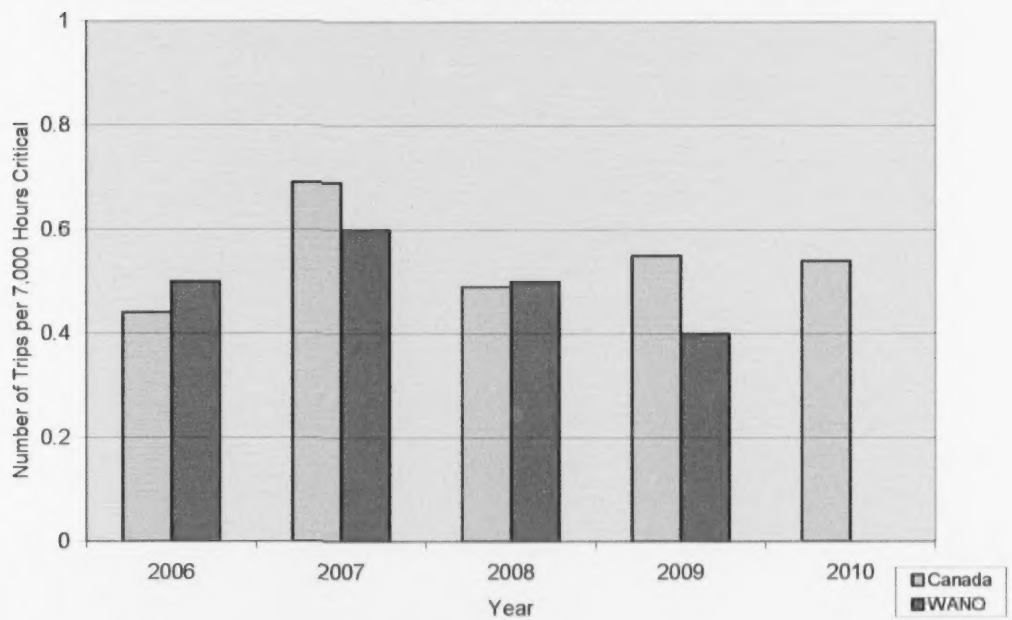
Figure 3 shows the number of trips per 7,000 operating hours (hours critical) for the Canadian nuclear power industry in comparison to international nuclear power industry values as published by the World Association of Nuclear Operators (WANO). The Canadian nuclear industry values have been slightly higher for two of the four years shown in the comparison; however, the difference between the Canadian and WANO values is marginal. In 2010, the trips for Canadian reactors decreased slightly to 0.54 per 7,000 operating hours.

Figure 2: Trend Details for Number of Unplanned Transients for Stations and Industry



	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau	Industry Total
2006	6	8	8	9	5	2	0	38
2007	12	3	2	10	4	5	2	38
2008	7	12	4	4	3	6	1	37
2009	4	9	0	9	6	4	n/a	32
2010	7	5	2	7	7	1	n/a	29

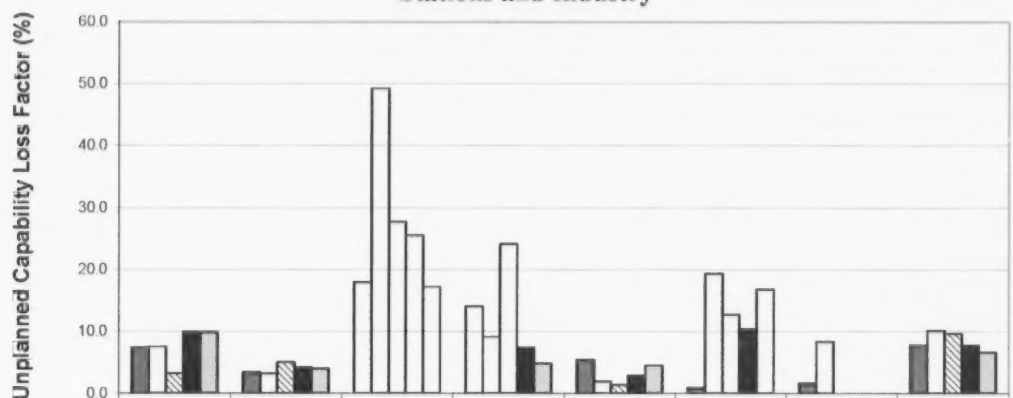
Figure 3: Trend Details for Number of Trips per 7,000 Hours Critical Compared to WANO Values



The "unplanned capability loss factor" (UCLF) PI is the percentage of the reference electrical output for the station not produced during the period due to unplanned circumstances. The purpose of this PI is to indicate how a unit is managed, operated and maintained, in order to avoid unplanned outages. The PI for most individual licensees and the industry as a whole continues to remain relatively low as shown in Figure 4 for the current year and the previous four years.

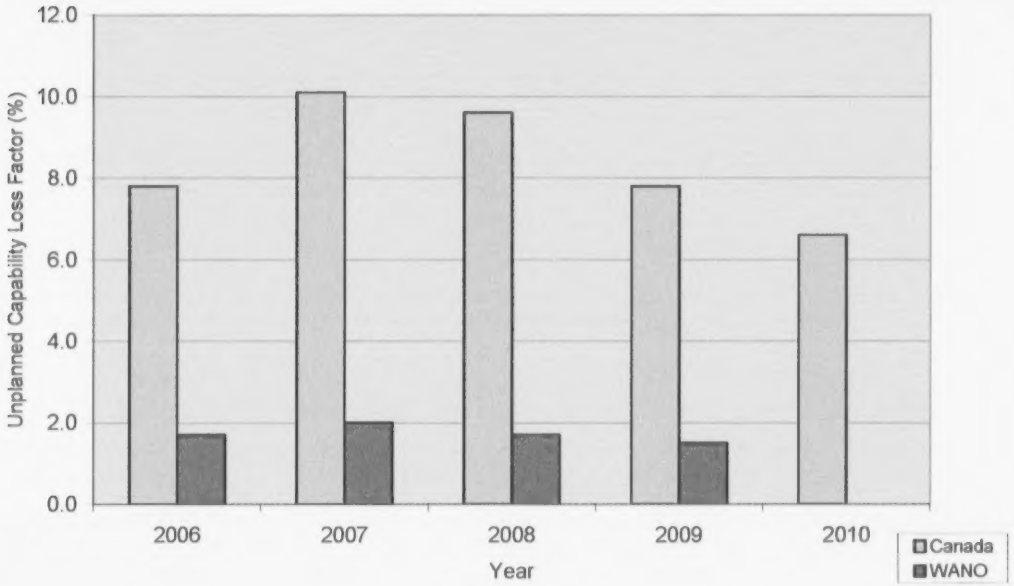
Figure 5 gives the UCLF for the Canadian nuclear power industry in comparison to international nuclear power industry values as published by WANO. The Canadian nuclear industry values are higher than the world average values. Since 2007 the industry-wide UCLF values for Canadian stations have been decreasing steadily, approaching those of the international community. The remaining variance can be explained by differences in reactor technologies, the number of reactors in each group (17 for Canada versus 434 reporting units for the WANO values) as well as station equipment maintenance and reliability all having an impact on the number of unplanned shutdowns or outage extensions.

Figure 4: Trend Details for Unplanned Capability Loss Factor for Stations and Industry



	Bruce A	Bruce B	Pickering A	Pickering B	Darlington	Gentilly-2	Point Lepreau	Industry
2006	7.4	3.4	17.9	14.0	5.4	0.9	1.6	7.8
2007	7.5	3.2	49.2	9.1	1.9	19.3	8.3	10.1
2008	3.2	5.0	27.7	24.1	1.3	12.7	0.0	9.6
2009	9.9	4.2	25.5	7.4	2.9	10.4	n/a	7.8
2010	9.8	4.0	17.2	4.8	4.5	16.8	n/a	6.6

Figure 5: Trend of Unplanned Capability Loss Factor (UCLF) Compared to WANO Values



Operating experience

The CANDU Owners Group (COG) is the main external interface for NPP licensees to obtain and submit operating experience (OPEX) information to the CNSC and each other. Once the information is obtained it is evaluated by licensee staff for significance and relevancy to their operations and acted upon as required. The information and evaluations remain available to licensee staff to be used in planning and performing tasks.

Reporting and trending

All NPP licensees have databases for managing information regarding identified problems. The information from these databases are reported and trended on an ongoing basis. Detailed cause evaluations of reported problems are limited to significant problems. Licensees have estimated that 75 to 80% of the problems entered into their databases are ones requiring trending. However, it has been noted that the trending performed is based on problem type and not cause. Causal trending allows for more effective identification of management system problems and the corrective actions required to avoid reoccurrence. Therefore, improvements are possible by industry NPPs in the area of causal trending and CNSC staff will monitor the effectiveness of the improvements implemented.

1A.4 Safety analysis

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Safety analysis	SA	SA	SA	SA	SA	SA	SA	SA

The safety analysis SCA pertains to the maintenance of the safety analysis that supports the overall safety case for each facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards. The industry average for this SCA in 2010 was "satisfactory".

The industry average rating of "satisfactory" for safety analysis is based on the licensees continuing to meet CNSC performance expectations for this SCA during the year and their adequate progress through COG research in a number of on-going safety analysis topics, namely:

- safety analysis improvement
- SOE
- impact of plant aging on safety analysis
- probabilistic safety assessment
- severe accident management (SAM)

Updates on some of the safety analysis issues or projects that apply to all licensees are:

Safety analysis improvement
In 2008, NPP licensees established a WG through COG to implement safety analysis improvement (SAI). The objectives of the SAI program include preparing for the implementation of RD-310, *Safety Analysis for Nuclear Power Plants*, assessing the impact of aging on the heat transport system, and evaluating the conservatism and correcting inconsistencies in the safety analyses.

CNSC staff have been participating in the SAI WG meetings and provided comments on the program and its results on a regular basis. CNSC staff support the industry's development of a principles and guideline document for safety analysis, in order to aid the implementation of new CNSC regulatory documents aimed at improving safety analysis. The CNSC finds the industry's work plans and schedules with respect to these activities to be acceptable. The activities and products of this WG are on schedule and have been communicated to the CNSC staff for review and comments.

Safe operating envelope
Established in 2009, the joint CNSC/Industry WG on Safe Operating Envelope (SOE) aims to develop a clear licensee approach to defining and implementing a SOE for their respective NPPs, ensuring consistency across licensees and alignment with international practices.

CNSC staff was involved in the development of the CSA Standard N290.15-10, *Requirements for the Safe Operating Envelope of Nuclear Power Plants*, published in August 2010. This standard provides the requirements and guidance for existing CANDU plants although it is also technology neutral.

Licensees are in various stages of preparation and revision of the SOE documents. OPG, Bruce Power and NB Power are completing the development and implementation of their SOEs, while Hydro-Québec is planning to start the SOE related activities in 2011.

Owing to the differences across the industry in the implementation of the SOE program, this specific area was not included in the determination of the rating of the safety analysis SCA.

Impact of plant aging on deterministic safety analysis

Plant aging and its impact on safety is important to industry and the regulator because, unless compensatory measures are implemented, aging reduces safety margins. CNSC staff require licensees' safety analyses to demonstrate that the plants are safe to operate during their licence period.

All licensees have developed station aging management programs (AMPs). One goal of these programs is to determine the impact of aging on the results of deterministic analyses in order to take appropriate actions to maintain the adequacy of safety margins and effectiveness of safety systems.

In 2010, OPG and Bruce Power made significant progress towards completing the activities aimed at addressing all the issues identified in the CNSC and Independent Expert Panel's reports on the new neutron overpower protection methodology that includes the impact of heat transport system (HTS) aging. OPG and Bruce Power have affirmed that the current NOP trip setpoints, are adequate for safe operation of their stations, based on their review of results of analytical and methodology related activities completed to date.

CNSC staff should be in a position to complete its review of the new NOP methodology by the first quarter of 2012, should no significant delays in the completion of OPG and Bruce Power activities occur or significant review findings emerge.

In 2010, CNSC staff received from OPG updated small break loss of coolant and loss of flow accident safety analyses that include the impact of HTS aging. In support of the review of these and other safety analyses, CNSC staff initiated two research projects: one is related to the criteria that will be used to judge the effectiveness of the shutdown systems and the second research project focuses on uncertainties associated with heat transfer correlations for CANDU fuel.

Probabilistic safety assessment

All NPP licensees have a requirement to conduct probabilistic safety assessments (PSAs) according to CNSC's Regulatory Document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. Licensees are required to develop, periodically review and update their PSAs, as necessary, in conjunction with their deterministic safety analysis. The PSAs, their methodologies and their updates are reviewed by CNSC staff using well accepted international guidance, to ensure compliance with the requirements in S-294.

At this time, all licensees are progressing well towards compliance with the requirements of S-294. A significant effort in updating the PSA methodologies and the PSAs using international best practices is proceeding and licensees are at various stages of implementation of their programs.

Severe accident management program

To address the effects of a severe accident, CNSC Regulatory Guide G-306, *Severe Accident Management Programs for Nuclear Reactors*, requires licensees to develop and implement measures to help:

- prevent the escalation of a reactor accident into an event involving severe damage to the reactor core
- mitigate the consequences of an accident involving severe damage to the reactor core
- achieve a safe, stable state of the reactor and plant over the long term

Following completion of the generic severe accident management (SAM) guidelines by COG, licensees have continued with the development and implementation of plant-specific SAM programs. This involves activities such as the development of plant-specific SAM procedures, establishing the organizational framework and the technical facilities for SAM organization, staffing, training, drills, and completion of design changes, as applicable.

The status of SAM programs varies from plant to plant according to plant-specific priorities and scheduling determined by factors such as the extent of efforts needed for design changes, and life extension projects. Significant progress toward completion of plant-specific SAM programs was recorded by Bruce Power and NB Power. At Hydro-Québec, the development and implementation of the SAM program is being approached in conjunction with the life extension project. At OPG, SAM guidelines are being implemented in two phases. Phase 1 has been focused on SAM guidelines implementation within the emergency response organization. From the information officially communicated to CNSC, OPG completed Phase 1 in 2010. Phase 2, Station-Specific Implementation, commenced in 2011. Phase 2 will include integration of SAM guidelines into operation procedures, evaluation of field modifications and design enhancements required for SAM guidelines implementation, validation of SAM guidelines strategies in the field, development of enabling instructions, etc. OPG has

committed to submitting the overall SAM guidelines implementation plan and progress report to the CNSC by May 28, 2011.

Robustness analysis for malevolent acts
The performance of this specific area is presented to the Commission in an addendum to a separate Commission Member Document (CMD 11-M46.A). The ratings were not used in calculating the safety analysis SCA ratings for the stations.

1A.5 Physical design

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Physical design	SA	SA	SA	SA	SA	SA	SA	SA

The physical design SCA relates to activities that impact on the ability of systems, components and structures to meet and maintain their design basis given new information arising over time considering changes in the external environment. The industry average rating for physical design was "satisfactory" in 2010.

Within the safety areas and programs framework used for previous NPP Reports, fire protection system design assessment was reported under the design program. For the 2010 NPP Report, fire design has been moved to the emergency management and fire protection SCA and has been assessed under the specific area for fire protection and response.

Equipment qualification
The equipment qualification assessment for licensees is based on the performance of their environmental qualification (EQ) programs. Overall, in 2010, the industry continued to perform well in their EQ programs, and all stations are assessed as satisfactory for this specific area. All licensees have implemented EQ programs, which have continued to mature since their initial implementation in 2004.

This program, which is compliant with the CSA N290.13-05, *Environmental Qualification of Equipment for CANDU Nuclear Power Plants*, applies to all systems, equipments, components, protective barriers, and structures credited to perform their safety functions if exposed to harsh environmental conditions resulting from certain design basis accidents.

From the initial implementation of the EQ program, both licensees and CNSC identified some challenges associated with activities necessary to preserve qualification status over the life of the plant; notably, EQ training, EQ condition monitoring, EQ program steam barriers and EQ document backlog. However, there were no major qualification issues identified during CNSC inspections of EQ programs in 2010.

System design and classification

Reactor control, process and control, instrumentation and controls including software
In 2010, instrumentation and control (I&C) ratings for licensees were based on the improvements of the degraded components. The industry has continued to improve the reliability of I&C systems through replacement projects and maintenance strategy. All stations were assessed to be satisfactory.

Service water systems, including emergency service water systems
The service water systems (SWS) supply water at low temperature to equipment, principally for cooling applications, but is also used for non-cooling functions, such as lubricating pump bearings and retaining pump seals.

While the service water systems provide water to a very large number of components and systems, from a nuclear safety perspective, the most important service water loads are associated with:

- The removal of heat originating from the nuclear fission reactions in the reactor core, e.g., moderator heat exchanger cooling and end-shield cooling. The reactor core is a continual source of heat under normal operating conditions and remains a heat source at decay power levels under shutdown conditions. In the absence of adequate cooling, the continual accumulation of core heat in various structures, systems and components (SSC) can challenge the integrity of the SSC.
- Cooling functions to ensure proper functioning of SSC important to safety; e.g., instrument air compressors and boiler room air cooling units.

During 2010, the SWS functioned well at all NPP stations with no significant issues.

Configuration management
Configuration management (CM) for an NPP is the process of identifying and documenting the characteristics of the plants SSCs, including computer systems and software and ensuring that the changes to these characteristics are properly addressed with respect to plant documentation. The licensee shall ensure that all the systems important to safety meet the design requirements and that plant documentation reflects the physical plant.

The overall CM baseline program has been implemented at all plants. However, there exist some minor weaknesses, in the area of CM sustaining activities, which interface with ongoing processes such as engineering change control, performance monitoring, maintenance, aging management and corrective actions.

Human factors in design
CNSC staff determined, from assessments and inspections, that there is the need for improvement throughout the industry in terms of incorporating human factors into engineering design changes. In general, human factors specialists have not been

sufficiently involved in the design process to ensure that the proposed design in its conceptual stage leads to an optimal modification.

Engineering change control

NPP licensees have implemented graded processes for the control and implementation of design changes to SSCs. The process evaluates the risk to safe operation of the change being introduced to determine the following:

- approval requirements for each individual design
- formality of planning
- commissioning requirements from formal commissioning tests to operational/ maintenance functional tests
- formality and degree of operational acceptance once the design change has been implemented

In 2010, CNSC staff did not identify weaknesses related to the implementation of engineering change control risk-based processes.

Robustness design

The performance of this specific area is presented to the Commission in an addendum to a separate Commission Member Document (CMD 11-M46.A). The ratings were not used in calculating the physical design SCA ratings for the stations.

1A.6 Fitness for service

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Fitness for service	SA	SA	FS	SA	SA	SA	SA	SA

The fitness for service SCA covers activities that impact the physical condition of systems, components and structures to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so. The industry average rating for this SCA was "satisfactory" in 2010.

The safety performance assessment of this SCA is presented according to the major areas that encompass fitness for service, namely, maintenance, reliability, periodic inspection of pressure boundary components and life cycle management.

Maintenance

Regulatory Document S-210, *Maintenance Programs for Nuclear Power Plants*, sets out expectations for maintenance programs, including a focus on managed processes. This document is being introduced as a licence condition upon power reactor operating licence (PROL) renewal. In 2010, it was added to the licence for Pickering A. Two licences that still remain without reference to S-210 are the PROLs for Gentilly-2 and Point Lepreau.

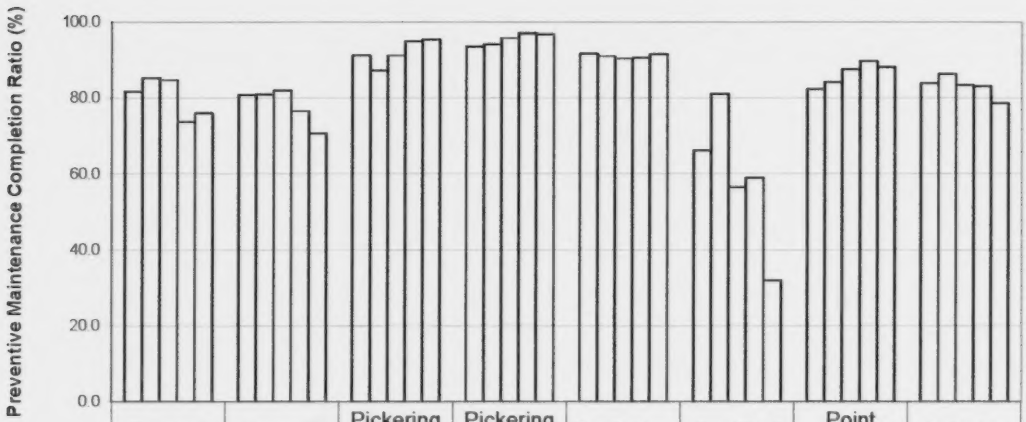
CNSC staff monitor licensee maintenance backlogs, in particular, corrective and elective maintenance backlogs, as indicators of maintenance effectiveness. The corrective maintenance backlog consists of all corrective work generated through work order requests and appears in the work management system as uncompleted work. The elective maintenance backlog is similar, except that it concerns equipment that is degrading but can still perform its design function. The combination of corrective and elective backlogs gives an indication of the plant's material condition with the proviso that there will always be a level of backlog, due to normal operations and equipment aging.

Both the corrective and elective maintenance backlog levels at most stations decreased during 2010. However, this will remain a focus area for CNSC staff until all stations achieve numbers in line with the best industry practice on backlog levels. There is an ongoing action for Pickering A and B maintenance backlog improvement and CNSC staff will continue to monitor progress in this area.

The preventive maintenance completion ratio (PMCR) PI is the ratio of preventive maintenance work orders completed on safety-related equipment divided by the total maintenance work orders (preventive maintenance plus corrective maintenance) completed on safety-related equipment. Preventive maintenance is considered to be actions that detect, preclude or mitigate degradation of a functional structure, system or component to sustain or extend its useful life by controlling degradation and failures to an acceptable level.

The PMCR monitors the effectiveness of the preventive maintenance program in minimizing the need for corrective maintenance activities. PMCR is a lagging indicator of preventive maintenance program effectiveness. Best industry practice sets a target of 90% or better for this indicator. In 2010, the average PMCR values for the OPG stations were above 90%, as seen in Figure 6. The PMCR values for Bruce Power were within the range of the industry average, and the value for Point Lepreau was approaching the target for best industry practice. The Gentilly-2 PMCR value was low due to a different reporting mechanism, and this difference will be addressed for future reporting of this PI. Although there has been a decline in the industry average during the past 5 years, four stations generally met or exceeded the best industry target in 2010. CNSC staff will continue to monitor the effectiveness of licensee's preventive maintenance programs to ensure the PMCR values will meet the industry target levels.

Figure 6: Trend Details for Preventive Maintenance Completion Ratio (PMCR)



	Bruce A	Bruce B	Pickering A	Pickering B	Darlington	Gentilly-2	Point Lepreau	Industry
2006	81.6	80.7	91.1	93.5	91.6	66.1	82.2	83.8
2007	85.2	80.8	87.2	94.0	90.9	81.1	84.1	86.2
2008	84.6	82.0	91.1	95.7	90.3	56.4	87.5	83.3
2009	73.7	76.5	94.8	97.0	90.5	58.9	89.6	83.0
2010	76.0	70.5	95.3	96.7	91.4	31.9	88.1	78.6

Reliability

Licensees have reliability programs based on the requirements given by Regulatory Document S-98, *Reliability Programs for Nuclear Power Plants*, in order to ensure that systems important to safety can and will meet their defined design and performance specifications at acceptable levels of reliability, throughout the life of the facility.

CNSC staff continue to meet with licensees to discuss progress on issues related to the implementation of Regulatory Document S-98. Meetings are organized on a regular basis through the COG Risk and Reliability group. During 2010 CNSC staff and industry representatives reached a common understanding on a number of topics, including:

- success (or failure) criteria in the system reliability modeling
- modeling of failures on demand and during mission time
- inclusion of support systems in the system reliability modeling
- inclusion of common-cause failures in the system modeling
- role of S-98 in the CNSC regulatory framework
- process system reliability performance evaluation

The "number of missed mandatory safety system tests" PI indicates the degree of completion of tests required by licence conditions. It is a measure of the licensee's ability to successfully complete routine tests on safety-related systems. Data for this PI for the stations and industry as a whole is shown in Table 6 and Figure 7. The recent overall trend displays a concerted effort by industry to reduce this parameter during 2010.

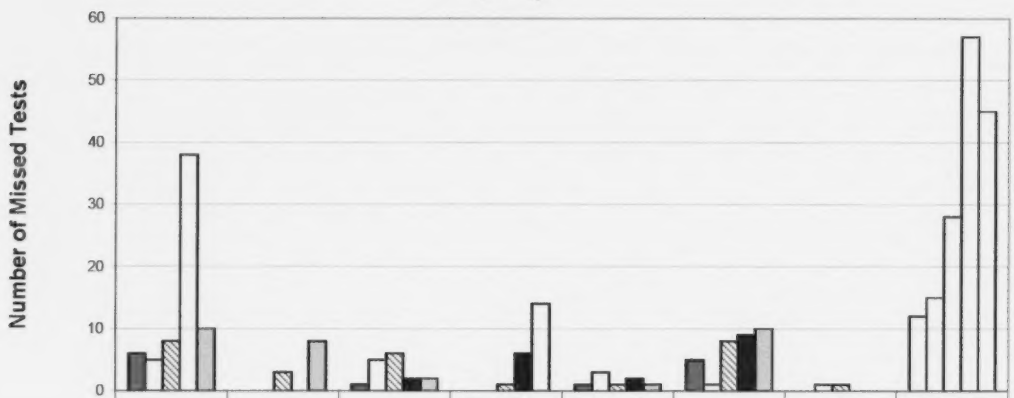
It should be noted that the missed tests represent an extremely low 0.05% of the total mandatory safety system tests performed by licensees during the year. This represents negligible risk since, for the majority of cases, these tests were performed shortly after the required time and involved safety systems with sufficiently high redundancy to ensure continuous safety system availability.

Table 6: Missed Mandatory Safety System Tests for 2010

Station	Total # Tests Performed	Missed Mandatory Safety System Tests			
		Special	Standby	Safety Related	Total
Bruce A	20,160	3	6	1	10
Bruce B	29,448	8	0	0	8
Darlington	14,400	2	0	0	2
Pickering A	13,375	13	1	0	14
Pickering B	13,345	1	0	0	1
Gentilly-2	4,414	2	3	5	10
Point Lepreau*	n/a	n/a	n/a	n/a	n/a
Industry Total	95,142	29	10	6	45

* Since the reactor has entered a defueled state, no tests have been scheduled at Point Lepreau.

Figure 7: Trend of Missed Mandatory Safety System Tests for Stations and Industry



	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau	Industry Total
2006	6	0	1	0	1	5	0	12
2007	5	0	5	0	3	1	1	15
2008	8	3	6	1	1	8	1	28
2009	38	0	2	6	2	9	n/a	57
2010	10	8	2	14	1	10	n/a	45

Periodic inspections

Periodic inspections and testing of CANDU NPP components, containment components and concrete containment structures, as well as in-service inspection of significant balance-of-plant (BOP) SSCs are mandatory requirements of the PROL. Licensees are required to implement and maintain periodic inspection and in-service inspection programs to address these areas in accordance with a series of CSA standards. The licensees periodic inspection and in-service inspection programs manage structural integrity of SSCs, including monitoring, fitness for service assessment, mitigation, and, if appropriate, the replacement of degraded components. Licensees perform periodic and in-service inspections to confirm that all NPP components described above remain fit for service.

NPP licensees carry out periodic inspections to confirm that major HTS components remain fit for service. These components include feeders, steam generator tubes and pressure tubes. In 2010, periodic inspections of major HTS components were performed satisfactorily at OPG and Bruce Power stations.

In general, all licensees have satisfactorily performed and reported periodic inspections results for containment components according to CSA N285.5, *Periodic Inspection of CANDU Nuclear Power Plant Containment Components*, and S-99, *Reporting Requirements for Operating Nuclear Power Plants*. OPG submitted its transition plan to the latest CSA standard in 2010, and is adhering to the transition plan timelines respecting all its NPPs. For Bruce Power, additional information has been requested to ensure a common understanding of the basis of the periodic inspection programs. Hydro-Québec has not submitted its CSA N285.5 program in 2010 but will submit the program in 2011 as part of its licence renewal.

For the transition to the newer version of CSA N287.7-08, *In-service Examination and Testing Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants*, Pickering submitted its revised periodic inspection programs (PIPs) which have been accepted by CNSC staff. Darlington and Point Lepreau also submitted their revised PIP documents to CNSC staff for review. Comments have been provided by CNSC staff and a schedule for transition is being established. Bruce Power has recently submitted its revised PIPs for CNSC staff to review. Hydro-Québec indicated that its PIP document meeting the requirements of CSA N287.7-08 will be submitted in 2011.

Regarding the AMP for concrete containment structures, all licensees, except Hydro-Québec, have submitted their AMPs to CNSC staff for review and acceptance. Review by CNSC staff of the AMPs is at various stages for the different licensees. Hydro-Québec is expected to submit the AMP for concrete containment structure in 2011.

In-service inspection for BOP

This is a new requirement that is being phased in on licence renewal. As of 2010, Bruce Power and Pickering A are required to implement and maintain programs for in-service inspection of BOP secondary side piping. Bruce Power has indicated that it plans to develop a lifecycle management plan as an additional measure for this area.

CNSC staff will be promoting the development of lifecycle management plans for all licensees in 2011 for BOP in order to support the development of the new CSA standard which will be incorporated in the PROLs.

1A.7 Radiation protection

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Radiation protection	BE	SA	FS	SA	SA	SA	SA	SA

The radiation protection SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations* (RPR). This program must ensure that contamination and radiation doses received are monitored and controlled. In 2010, the industry average rating for the radiation protection SCA was "satisfactory".

All licensees have implemented and maintained a radiation protection (RP) program to control the radiological hazards present in their facilities and have ascertained and recorded doses for each person who performed duties in connection with their licensed activities, as required by sections 4 and 5 of the RPR.

The overall objective of the RP program is to ensure that radiation exposures to workers and members of the public are kept as low as reasonably achievable (ALARA), social and economic factors taken into account.

In 2010, there were no radiation exposures reported by any NPP that exceeded the worker regulatory limits (i.e., 50 milliSieverts (mSv)/year and 100 mSv/5-year dosimetry period).

Based on operating experience from an event that occurred in 2009 and that was reported in the 2009 NPP Report, Bruce Power determined that historical uptakes of alpha may have occurred in workers from their operating reactor units. Given this new discovery and the potential for alpha exposure of workers in the industry, CNSC staff requested in June 2010, pursuant to subsection 12(2) of the GNSCR, that all NPP licensees complete actions to ensure adequate alpha monitoring and control at their facilities. All licensees implemented immediate actions to ensure workers' safety. These actions were reviewed and deemed acceptable to CNSC staff.

Furthermore, CNSC staff communicated expectations for long-term corrective actions to enhance licensees' RP programs to meet industry best practices taking into account operating experience related to the monitoring and protection against alpha hazards. All NPP licensees have communicated their long-term corrective action and implementation plans to CNSC staff, which have subsequently been reviewed and accepted.

Because many licensees are operating as well as refurbishing their NPPs, this presents emerging challenges to RP programs with respect to additional maintenance and inspection requirements. At Bruce A and Point Lepreau, technical difficulties and delays during refurbishment presented RP demands in meeting collective dose targets for these facilities.

CNSC staff continue to monitor the effectiveness of the NPP licensees' RP programs, including the implementation of long-term improvements related to alpha monitoring and control, through inspections and document reviews to ensure continued safety of workers and the public.

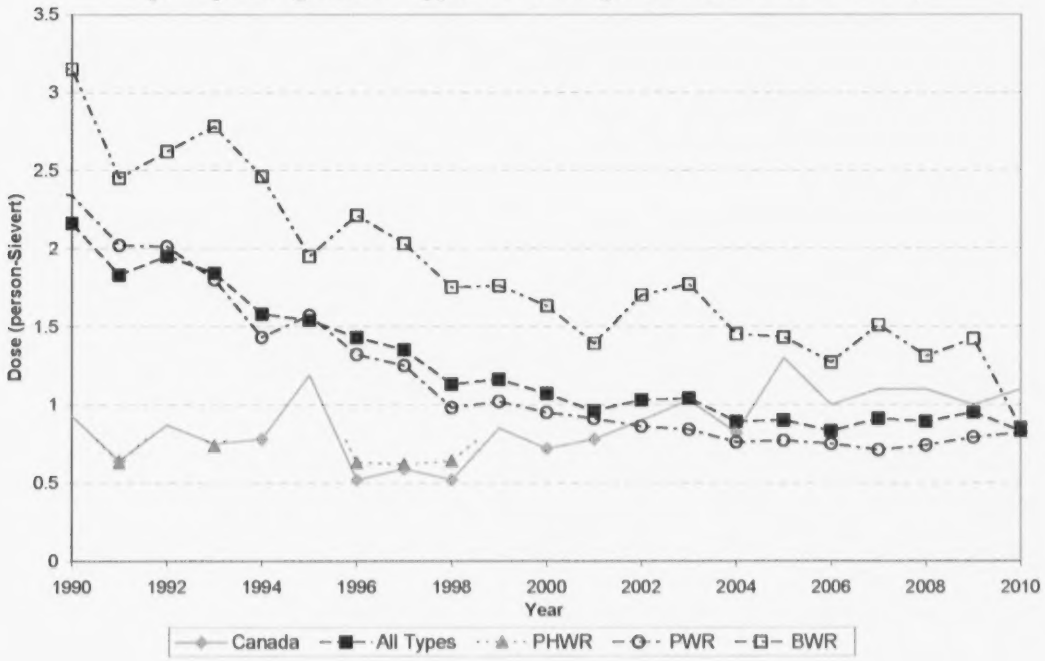
The annual workers collective dose for licensees and for industry is presented in Appendix F.

A comparison of the collective dose per reactor unit for Canada[1] versus international values[2] for different reactor types —pressurized heavy water reactors (PHWRs), boiling water reactors (BWRs), pressurized water reactors (PWRs) and all reactor types— for operations (routine operations and outages) is provided as Figure 8. It can be seen that Canada's reactors have maintained an average annual collective dose per reactor unit of around 1 person-Sievert for recent years with the exception of 2005 where the collective dose was driven higher for most units due to outage work. The Canadian collective dose per reactor unit value has been lower than PHWR operators since 2008. In 2010, Canada's collective dose per reactor unit was 0.28 person-Sieverts higher than the PWR collective dose per reactor unit, reflecting the tritium dose component for heavy water moderated reactors. The international trend has been one of a reduction in the collective radiation dose for the past 20 years as seen in Figure 8 in the curves for PWRs, BWRs and all reactor types. For Canada, the observed industry trend has been a convergence on a collective dose per reactor unit of around 1 person-Sievert.

[1] Canadian collective dose values excluding refurbishment collective dose from Bruce A Units 1 and 2 and Point Lepreau

[2] international dose data extracted from the Information System on Occupational Exposure database (http://www.isoe-network.net)

Figure 8: International Benchmarking for Average Collective Radiation Dose per Operating Reactor Type, 1990-2010 (person-Sievert/Reactor Unit)



1A.8 Conventional health and safety

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Conventional health and safety	FS	FS	FS	SA	SA	SA	SA	SA

Conventional health and safety covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment. The industry average for conventional health and safety was "satisfactory" in 2010.

The licensees are responsible for developing and implementing a conventional health and safety program for the protection of their staff and contract workers regardless of their place of employment in the nuclear facility. The conventional health and safety programs for the industry, as well as their implementation, were compliant with applicable portions of the *Canada Labour Code* and/or referenced provincial legislation.

One of the parameters used for measuring the effectiveness of the conventional health and safety program with respect to worker safety is the "accident severity rate" (ASR) PI. It is a measure of the total number of days lost due to a work-related disabling injury for every 200,000 person-hours (approximately 100 person-years) worked at the station.

However, caution is advised when comparing the ASR value for different licensees, due to the differences among organizations with respect to definitions of industrial accidents, jurisdiction of worker safety, and the interpretation of lost time associated with chronic health problems. For example, depending on work assignments, a worker with a similar back injury might be assigned non-physical work by one licensee, while classified as a disabling injury accident by another licensee. Furthermore, accident severity is one of three specific areas (see Appendix A) used in determining the rating for conventional health and safety.

The ASR PI values for the stations and the industry average are presented in Table 7 and Figure 9. It is noted that there has been a general increase in the ASR values for stations as well as for the industry average value for 2010. The Point Lepreau ASR value is relatively high on account of six disabling injuries and also due to the methodology used by Point Lepreau for classifying a disabling injury. Point Lepreau uses all disabling injuries in its calculation while the other licensees report only injuries for which restricted work cannot be assigned.

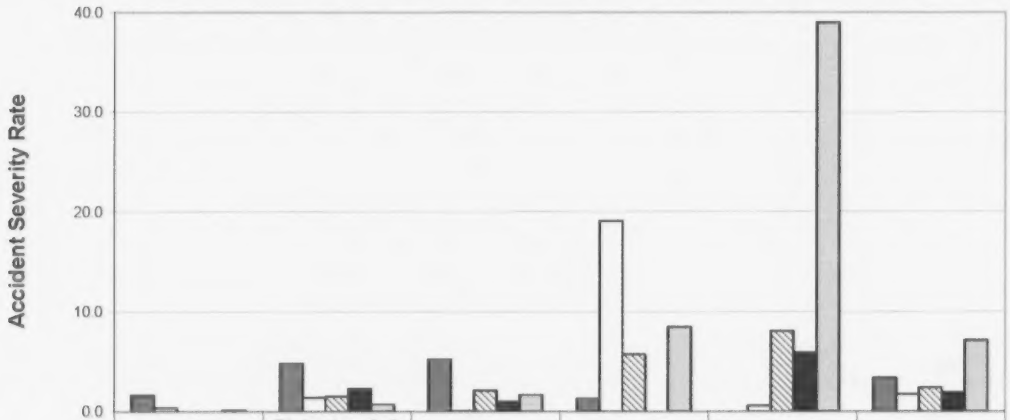
Table 7: Accident Severity Rate for 2010

Station	Days Lost	Person Hours	Accident Severity Rate
Bruce A and B	5	8,199,508	0.12
Pickering A and B	30	8,401,300	0.71
Darlington	43	5,246,256	1.64
Gentilly-2	101	2,393,378	8.44
Point Lepreau	833	4,276,022	38.96
Industry Average	1,012	28,516,464	7.10

Note: Due to differences in reporting of disabling injury methodologies, the ASR values therefore cannot be compared directly.

Figure 10 shows ASR values for the Canadian nuclear power industry since 2006 in comparison to values for other Canadian and provincial industries. The other industries shown in the comparison include members of the Canadian Electricity Association, construction, mining and petroleum and transportation, communication and utilities. In general, accident severity rates for Canadian NPPs are comparable to other industries and lower than those reported by the Canadian Electricity Association.

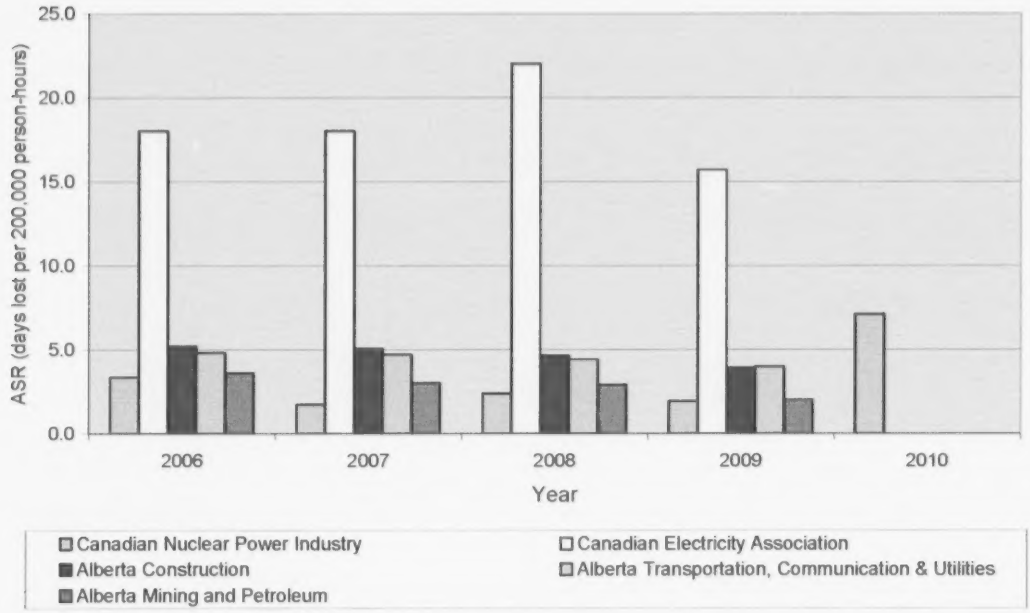
Figure 9: Trend Details of Accident Severity Rate for Stations and Industry



	Bruce A & B	Pickering A & B	Darlington	Gentilly-2	Point Lepreau	Industry
2006	1.6	4.8	5.2	1.3	0.0	3.4
2007	0.3	1.4	0.1	19.1	0.6	1.7
2008	0.0	1.5	2.1	5.7	8.0	2.4
2009	0.0	2.3	1.0	0.0	5.9	1.9
2010	0.1	0.7	1.6	8.4	39.0	7.1

Note: The ASR data for Point Lepreau is reported using a different basis, as previously mentioned.

Figure 10: Trend Details of Accident Severity Rate (ASR) for Canadian Industries



1A.9 Environmental protection

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Environmental protection	SA	SA	SA	SA	SA	SA	SA	SA

The environmental protection SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances and the effects on the environment from facilities or as the result of licensed activities. The industry average rating for this SCA was "satisfactory" in 2010.

The dose to the public from each Canadian NPP for both airborne emissions and liquid releases in 2010 is provided in Figure 11. The figure shows that the doses to the public are well below the regulatory public annual dose limit of 1,000 microSieverts (μSv) and negligible in comparison to the amount of radiation dose Canadians receive from natural background radiation sources (2,400 μSv). To put the dose to the public values shown in Figure 11 in perspective, typically a Canadian would receive approximately 6.6 μSv daily from natural background radiation. The **annual** dose to the public from an NPP (up to 4.4 μSv annually during the past three years) is less than what a Canadian would receive in a **single day** from natural background radiation. Also shown for comparison purposes are the values for 2008 and 2009. The comparison shows that the 2010 dose values are lower than the 2009 values for Canadian NPPs.

Airborne emissions and liquid releases for 2010 are shown in Figures 12 and 13, respectively.

Licensees establish action levels that are set at 10% of the derived release limits (DRLs) and the DRLs are stated in each PROL. These action levels, if reached, would indicate a loss of control of part of the licensee's environmental program and the requirement for specific actions to be taken and reported to CNSC. Both airborne emissions and liquid releases were lower than the DRLs in 2010. Except for a monthly liquid release activity level exceeding an action level in June at Pickering B (see section 1B.4.9 for additional details) both airborne emissions and liquid releases were lower than the monthly action levels.

Figure 11: Comparison of Dose to the Public from Canadian NPPs for 2008 to 2010

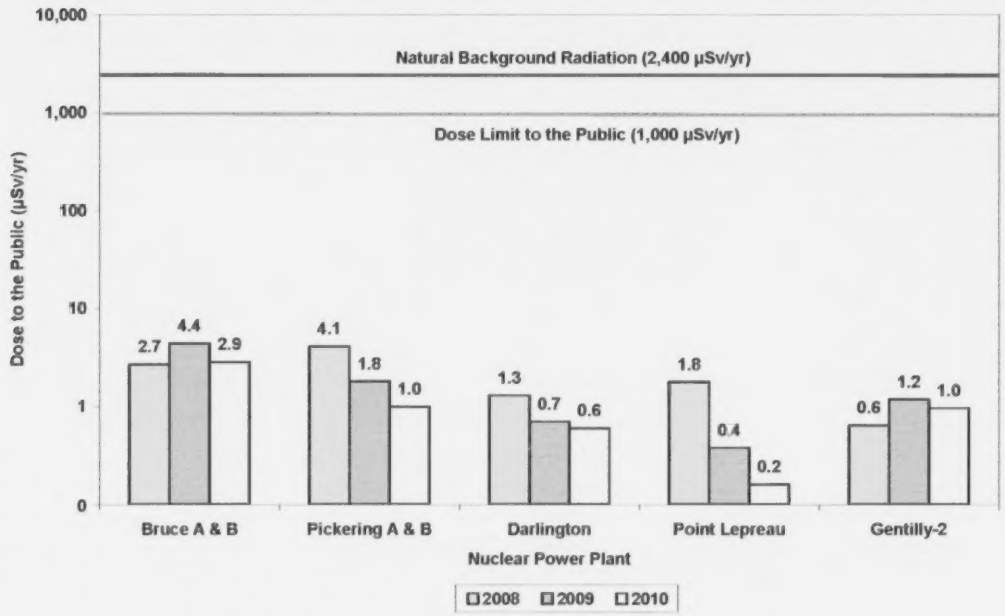


Figure 12: Radionuclides Emitted to Air by Canadian NPPs in 2010

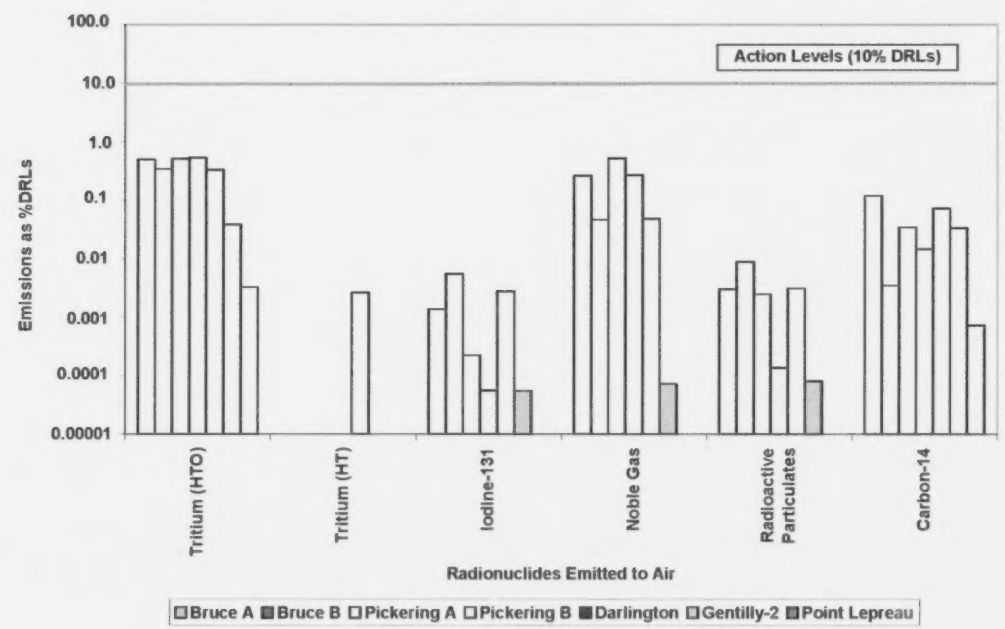
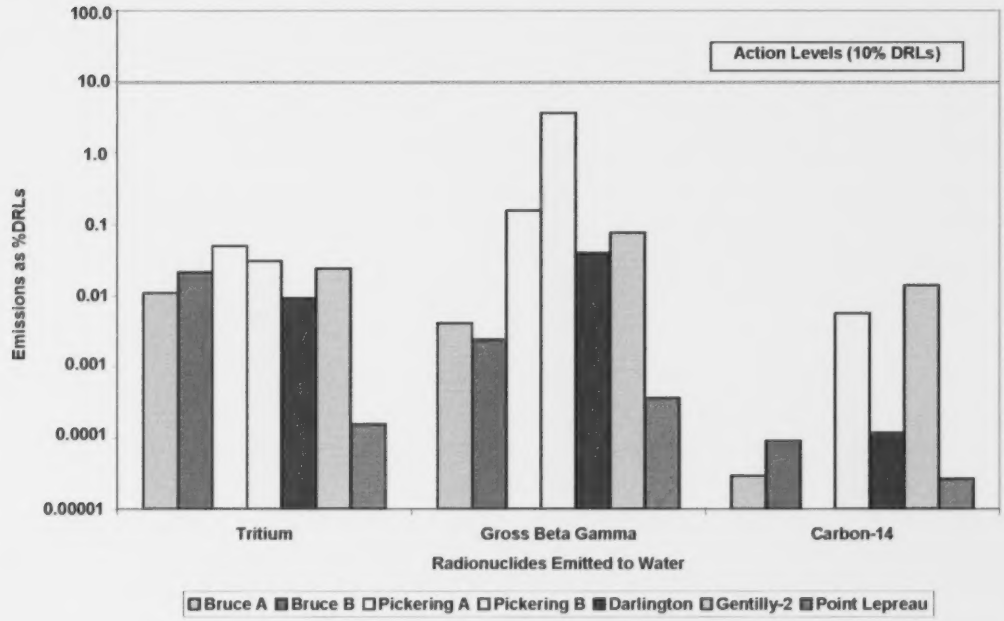


Figure 13 : Radionuclides Emitted to Water by Canadian NPPs in 2010



1A.10 Emergency management and fire protection

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Emergency management and fire protection	SA	SA	SA	SA	SA	SA	BE	SA

The emergency management and fire protection SCA covers emergency plans and emergency preparedness programs for emergencies for non-routine conditions. This also includes any results of exercise participation. The industry average for this SCA was "satisfactory" in 2010.

Canadian NPP stations continue to maintain mature and compliant emergency preparedness programs and fire protection programs that meet industry standards and CNSC regulatory performance expectations.

However, Point Lepreau was rated "below expectations" for this SCA due to the low performance in the "fire protection and response" area. This rating was based on observed deficiencies in 2010 in the area of fire brigade and emergency response team drills. Point Lepreau has been directed to improve its emergency response team capability, performance and training. The effectiveness of corrective actions will be closely monitored by CNSC staff as part of the return to service regulatory oversight activities.

Reactors undergoing refurbishment require greater emphasis on different or new areas of emergency preparedness planning. For example:

- emergency preparedness plans and procedures for dealing with mixed work sites (i.e., major refurbishment projects on the same site as operating reactors)
- emergency preparedness readiness, particularly with respect to working with off-site response organizations
- potential impacts on licensee emergency preparedness programs, due to proposed operating life extensions of existing reactors

Licensees maintain up-to-date plans for business continuity in case of possible disruption due to a variety of predefined issues. These plans would be utilized to ensure plant safety and minimum staff complement in the event of a disruption. With increasing emphasis on business continuity planning, the CNSC has endeavoured to introduce assessment of this important area for the first time in the 2010 NPP Report, for licensees where information on the safety performance of the business continuity plan was available.

In general, Canada's NPPs are implementing CSA N293-07, *Fire Protection of CANDU Nuclear Power Plants*. The implementation process includes the following main tasks: revision of the Code Compliance Review (i.e., gap analysis) and revision to the facilities' fire hazard assessment and fire safe shutdown analysis. These tasks are being performed using modern methodologies that evaluate the level of fire protection, while taking into consideration current knowledge and industry best practices. Due to the complexities and specialty knowledge required to carry out these tasks, licensees have had to modify the original timeline for the completion of these tasks from those initially identified in their respective LCHs; however, progress in the tasks to date is considered to be acceptable. CNSC staff continued to monitor progress for the completion of the code compliance review, the fire hazard assessment and the fire safe shutdown analysis, as well as recommendations for modifications and upgrades that may arise from these tasks.

1A.11 Waste management

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Waste management	SA	SA	SA	SA	SA	SA	SA	SA

The waste management SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This also covers the planning for decommissioning. The industry average rating for the waste management SCA in 2010 was "satisfactory".

The industry NPPs have a radioactive waste management program in place that documents requirements for the minimization, segregation, handling, monitoring and processing of radioactive waste. The program requires the assessment of the hazard levels

for all radioactive waste. Based on this assessment, all radioactive waste is disposed of appropriately in accordance with NPP regulations and internal procedures.

In 2010, CNSC staff inspections noted minor areas for improvement in the area of waste minimization, segregation and characterization; however, these findings did not have an effect on the overall effectiveness of the program. The industry's waste management program met CNSC staff's expectations in 2010.

Preliminary decommissioning plan

Decommissioning is referred to as those actions taken in the interest of health, safety, security and the environment, to retire a licensed facility or site permanently from service and render it to a predetermined end-state condition.

As a requirement of the *Class I Nuclear Facilities Regulations*, all power reactor licensees are required to maintain an acceptable preliminary decommissioning plan (PDP) which details how the nuclear facility will be decommissioned. PDPs must remain current and must be revised within a five-year review cycle, or when required by the Commission or a person authorized by the Commission. This is done in order to incorporate operational experience, technological advances and changes in the planning assumptions.

CNSC staff observed that the PDPs for all Canadian NPPs have remained valid and current during 2010. In addition, all PDPs have been revised within the last five-year period, as required.

1A.12 Security

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Security	Prescribed							Prescribed

The security SCA covers the programs that licensees are required to implement and that support the security requirements stipulated in the regulations, in their licences, in orders, or in expectations for their facility or activity. Due to the prescribed nature of this SCA, no industry average rating or individual station ratings are given in this report. However, the individual NPP station safety performance ratings for security are presented to the Commission in a separate Commission Member Document (CMD 11-M46.A).

1A.13 Safeguards

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Safeguards	SA	SA	SA	SA	SA	SA	SA	SA

The safeguards SCA covers the programs required for the successful implementation of the obligations arising from the Canada/IAEA Safeguards Agreement. The industry average rating for safeguards was "satisfactory" in 2010.

Safeguards is a system of inspection and other verification activities undertaken by the International Atomic Energy Agency (IAEA) in order to evaluate a State's compliance with its obligations pursuant to its safeguards agreement with the IAEA. Canada has entered into a safeguards agreement with the IAEA pursuant to its obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons*. The objective of the Canada–IAEA Safeguards Agreement is for the IAEA to provide annual assurance to Canada and to the international community that all declared nuclear material is in peaceful, non-explosive uses and that there is no indication of undeclared nuclear material or activities. The CNSC is the governmental authority responsible for implementing the Canada–IAEA Safeguards Agreement.

To implement safeguards requirements at the facility level, the CNSC requires that licensees put in place a program and appropriate procedures to ensure that safeguards can be implemented effectively and in a manner consistent with Canada's obligations. These requirements are described in the facility's licence, and the LCH, where appropriate, and also in the NSCA and CNSC regulatory documents. For the safeguards SCA, CNSC staff evaluate the licensee's program and procedures and their implementation in order to assess compliance with the licence conditions.

The IAEA's findings and conclusions for Canada as a whole are presented to the IAEA Board of Governors each June in the *Safeguards Implementation Report*. Although there are interim reports from the IAEA on inspection activities at specific facilities, the IAEA has yet to finalize its 2010 evaluation at the State or facility level. However, a positive overall assessment is expected by CNSC staff.

In 2010 the CNSC introduced the Regulatory Document RD-336, *Accounting and Reporting of Nuclear Material*, and an associated guidance document to replace the previous document, AECB-1049/ Rev. 2, *Reporting Requirements for Fissionable and Fertile Substances*. This regulatory document ensures consistency in record-keeping and reporting of nuclear material, in accordance with Canada's international obligations and sets out the requirements for accurate and standardized accountancy of nuclear material inventories and flows. Outreach meetings were held with licensees in August and September 2010 to address application and use of the two documents. CNSC staff assisted licensees through working level consultations in an effort to ensure compliance and understanding for the implementation date of January 1, 2011.

1A.14 Packaging and transport

	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Packaging and transport	SA	SA	SA	SA	SA	SA	SA	SA

The packaging and transport SCA pertains to programs that cover the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility. This is the first year for inclusion of this SCA in the NPP Report and, consequently, the compliance verification strategy on the packaging and transport SCA needs to be developed. However, based upon CNSC site staff knowledge, observations and other regulatory compliance information, the industry average rating for packaging and transport was determined to be "satisfactory".

Nuclear substances originating from NPPs are transported using packages that meet CNSC regulatory requirements and in many cases, the package designs have been certified by the CNSC. Common shipments include transport of radioactive waste in liquid and solid form, samples containing nuclear substances and tritiated heavy water.

NPP licensees are required to have appropriate training for personnel involved in the handling, offering for transport and transport of dangerous goods and are required to issue a training certificate to those workers in accordance with the *Transportation of Dangerous Goods Regulations*.

Many NPP licensees maintain a fleet of vehicles used for the transport of certified packages and maintain a list of third party carriers that may be used for shipments of nuclear substances.

NPP licensees comply with the *Packaging and Transport of Nuclear Substances Regulations* (PTNSR) requirements for all shipments of nuclear substances leaving their site. They prepare and maintain documentation demonstrating that the packages used to transport nuclear substances meet the requirements specified in the PTNSR.

Minor transport events were reported under the PTNSR by NPP licensees within the reporting period, and CNSC staff found the corrective actions implemented to be acceptable.

1B – Station performance

This section is organized by station, with performance ratings provided for each SCA (with the exception of security, as previously indicated). The ratings reflect CNSC staff's evaluation of how well licensees' programs met regulatory requirements and expectations and contributed to the overall health, safety and security of Canadians and the environment, in addition to meeting Canada's international commitments on the peaceful use of nuclear energy.

The safety performance ratings were determined using a risk-informed approach of integrating findings from Type I and Type II inspections, S-99 reportable events, and desktop reviews of events and progress on enforcement actions by CNSC staff.

1B.1 Bruce A and Bruce B

Table 8 presents the performance ratings for Bruce A and Bruce B in 2010. The 2010 integrated plant ratings for Bruce A and B were both "satisfactory".

Bruce A and B are grouped together for the purpose of this report since the operator, Bruce Power, uses common programs at both stations. However, as the implementation of programs may be different for Bruce A and Bruce B, the performance of each station is assessed separately.

There were no serious process failures at Bruce A or B, during 2010. No worker or member of the public received a dose in excess of the regulatory dose limits, and all environmental emissions were below regulatory limits and station action levels.

Based on these observations and the assessments of the SCAs, CNSC staff conclude that Bruce A and B were operated safely in 2010.

Table 8: Performance Ratings for Bruce A and B for 2010

Safety and Control Area	Rating		Industry Average
	Bruce A	Bruce B	
Management system	SA	SA	SA
Human performance management	SA	SA	SA
Operating performance	SA	SA	SA
Safety analysis	SA	SA	SA
Physical design	SA	SA	SA
Fitness for service	SA	SA	SA
Radiation protection	BE	SA	SA
Conventional heath and safety	FS	FS	SA
Environmental protection	SA	SA	SA
Emergency management and fire protection	SA	SA	SA
Integrated plant rating	SA	SA	SA
Waste management*	SA	SA	SA
Security**	Prescribed	Prescribed	Prescribed
Safeguards**	SA	SA	SA
Packaging and transport*	SA	SA	SA

* Waste management and packaging and transport were excluded from the integrated plant rating as not all NPPs have operating licences in the new format with a LCH that utilizes the new SCA structure.

** Security and safeguards were excluded from the integrated plant rating, in recognition that these areas correspond to important elements of CNSC's mandate that complement — but are separate from — the mandate to protect health, safety, and the environment.

1B.1.1 Management system

Bruce A and B met the CNSC regulatory requirements and performance expectations for the management system and this SCA was rated "satisfactory" for 2010.

The Bruce A and B operating licences contain a licence condition requiring compliance with the Canadian Standards Association (CSA) management standard N286-05, *Management System Requirements for Nuclear Power Plants*. The CNSC monitored Bruce Power's activities in accordance with the updated standard. Throughout 2010 Bruce Power management performance conformed to requirements in CSA N286-05. CNSC assessments did not identify any deficiencies with changes made to the documented management system.

1B.1.2 Human performance management

Bruce A and B's performance in the human performance management SCA was "satisfactory" in 2010.

CNSC staff are satisfied that Bruce A and B have sufficient staff in all relevant job areas with the necessary knowledge, skills, procedures and tools in place to safely carry out their duties. There were no significant issues resulting from inspections of the training, examination and certification programs in 2010.

The Commission has specified in Bruce Power's licences the required minimum shift complement tables, which ensure that Bruce A and B have sufficient qualified staff for the safe operation of the nuclear facility and adequate emergency response capability.

Bruce Power is currently working on a project to re-analyze the adequacy of the minimum shift complement numbers and qualifications according to the expectations in CNSC Regulatory Guides G-323, *Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement*, and G-278, *Human Factors Verification and Validation Plans*. CNSC staff are monitoring progress on this project, and if Bruce Power proposes a revision to these staffing levels it will have to request from the Commission an amendment to its power reactor operating licence.

In 2010, Bruce A's pass rate for initial certification examinations was 97%, while the Bruce B pass rate was 94%. Bruce Power's overall pass rate for requalification was 100%.

1B.1.3 Operating performance

Bruce A and B's performance in the operating performance SCA was "satisfactory" in 2010.

Bruce A and B operated safely in 2010 and all specific areas of this SCA contributed adequately to the stations safe operation. Operations inspections conducted by CNSC staff in 2010 found that the licensee had good compliance with CNSC requirements and licensee's governing procedures and documents. The licensee also met CNSC expectations for outage management and safety and adequacy of procedures.

In 2010, Bruce A experienced one trip, one stepback and five setbacks. Bruce B experienced one trip, three stepbacks and one setback. Many of the unplanned transients in 2010 were setbacks, which do not have a significant impact on plant operations.

In addition, stepbacks and setbacks were controlled properly and power reduction was automatically initiated by the reactor control systems. CNSC staff verified that for all events Bruce Power staff followed approved procedures, investigated or evaluated the reason for the plant upset and took appropriate corrective actions.

In 2010, Bruce A experienced six forced outages and Bruce B experienced two forced outages. There were no serious process failures at either station.

There was one planned outage at Bruce A for Unit 3, along with two planned outages at Bruce B for Units 5 and 6. Bruce Power completed all outages successfully. CNSC staff verified that adequate provisions were in place for reactor safety, completion of regulatory committed work, planned and discovered work. Except for the Bruce Unit 6 tritium release event (see next paragraph), Bruce Power maintained overall outage doses at or below ALARA targets.

On May 31, 2010, Bruce B Unit 6 was in the shutdown state undergoing a maintenance outage. During valving operations in preparation for the application of an ice plug on the liquid injection shutdown system, a flow path was inadvertently set up from the Moderator system through a vent line into the active ventilation system exhaust. A release of tritium outside containment resulted in 19 workers exceeding the action level of 2 mSv for dose from tritium uptake. No regulatory dose limits were exceeded. The radiological aspects of this event are discussed in section 1B.1.7, "Radiation protection".

In June 2010, CNSC staff conducted a focused inspection for this event. The inspection concluded that Bruce Power had demonstrated rigour in its approach by initiating three root cause analyses (RCAs):

- a technical RCA to determine how the spill occurred
- an RP RCA to determine why the radiological consequences were so high and how the worker doses could have been prevented or mitigated
- a communications RCA to determine how to improve the communications with workers after the event

Bruce Power's RP RCA for the tritium release determined a number of main causes and CNSC staff concluded that Bruce Power is taking appropriate corrective actions to address these causes and thereby mitigate a reoccurrence of a similar event. Bruce Power's corrective actions included improvements to the RP program, changes to operator procedures to improve awareness and changes to station protocols for declaring alerts. The main improvement was the installation of alarming tritium monitors throughout the stations. This new instrumentation has already been effective in warning station staff of elevated tritium levels due to malfunctioning equipment. Due to its operational nature, that is, the use of an incorrect flow path, the safety significance of the moderator spill event was not considered for rating the Bruce B radiation protection SCA.

1B.1.4 Safety analysis

Bruce A and B's performance in the safety analysis SCA was "satisfactory" in 2010.

In 2010, Bruce Power submitted the project plan for complying with Regulatory Document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*, which was reviewed by CNSC staff. The activities completed to date show considerable progress and are satisfactory. Adequate progress was made in a number of on-going safety analysis programs or topics: safety analysis improvement (SAI) program, safe operating envelope, and impact of plant aging on safety analysis.

1B.1.5 Physical design

Both Bruce A and Bruce B's performance in physical design was rated "satisfactory" in 2010.

In 2010, Bruce Power submitted documentation related to the transition to CSA N285.0-08, *General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants*, showing how all pressure boundary requirements are being met and this is being reviewed by CNSC staff. This documentation will be part of Bruce Power's management system. CNSC staff are also continuing the review of Bruce Power's heat transport system AMP based on new methodology. CNSC staff have not identified any significant issues in these submissions.

The overall configuration management baseline program at both stations has been implemented. This program relies on interfaces with other processes such as engineering change control and aging management.

As per the provisions of its LCHs, Bruce Power has submitted a transition plan to revise the fire protection code compliance review, the fire hazard assessment and the fire safe shutdown analysis in accordance with the requirements of CSA N293-07, *Fire Protection for CANDU Nuclear Power Plants*; the deadline for this transition is December 2011.

The environmental qualification (EQ) program is fully implemented for Bruce A and Bruce B and will ensure that all required systems, equipment, components, and barriers are qualified to perform their safety functions. This EQ program will also be fully implemented prior to restart of Units 1 and 2 in 2011. As part of the ongoing compliance program, an inspection of Bruce A's EQ program is planned in 2011 to verify the sustainability of the requirements.

1B.1.6 Fitness for service

Both Bruce A and B's performance in the fitness for service SCA was "satisfactory" in 2010.

Fitness for service relates to programs which impact on the physical condition of the plant structures, systems and equipment. Additional details are provided for each program in the following text.

High corrective maintenance backlogs were previously identified as a CNSC staff concern in the 2008 and 2009 reports. Since then Bruce Power has resourced and focused its maintenance activities, such that corrective maintenance backlogs have improved and met internal station targets for 2010. Although this continues to be an area of focus for Bruce Power, CNSC staff maintenance inspections carried out in the 2010 operating year concluded that Bruce Power has improved its overall conduct of maintenance and met the requirements of Regulatory Document S-210, *Maintenance Programs for Nuclear Power Plants*. In 2010, Bruce Power cut the corrective maintenance backlogs in half at both

stations. CNSC staff will continue to focus on this area until Bruce Power reaches backlog numbers that are in line with industry best practices.

Bruce Power reliability program requirements are determined by Regulatory Document S-98, *Reliability Programs for Nuclear Power Plants*.

As per the provisions of its LCHs, Bruce A and B provided the gap assessment and committed to providing the formal schedule and plan for S-294 compliance according to the risk assessment action plan. In the meantime Bruce Power continues to rely on its existing risk assessments. CNSC staff find that the Bruce Power activities met requirements in 2010.

No significant findings related to pressure boundary degradation at Bruce A or B were identified during the 2010 inspection campaigns. However, CNSC staff noted that the quarterly leakage rate test for Bruce A containment structure performed in February 2010 resulted in a leakage increase above the operating limit, but below the safety limit. A leak repair campaign has been initiated by Bruce Power and repairs are to be executed as per the work management process. CNSC staff will monitor the progress of this campaign.

In 2010, Bruce Power submitted a request for approval to CNSC for the deferral of the Bruce B station containment outage (SCO) from 2010 to 2012. At the same time it was evident that Bruce Power would not be able to perform the vacuum building pressure test before the end of 2010. Recognizing this situation, CNSC staff provided the assessment for the SCO deferral and review comments were provided. Bruce Power has committed to perform the vacuum building positive pressure leakage rate test, no later than December 2012.

The periodic inspections at Bruce A and B were conducted as per station PIPs and the requirements of CSA standards N285.4 and N285.5. Bruce Power has updated the PIP documents for plant structures and components to meet the requirements of the new versions of standards CSA N285.4-05, CSA N285.5-08 and CSA N287.7-08.

The latest revision to the PIP document to achieve compliance with N285.4-05 was reviewed by CNSC staff. Bruce Power has responded to CNSC staff's subsequent request and the additional information is currently under review. Constituent PIP programs for the feeders and fuel channels have been accepted by CNSC staff while the remaining steam generators and overall general program are close to being acceptable.

In 2010, Bruce Power submitted the revised CSA N287.7 PIP documents. This submission included the AMP for concrete containment structures and the common industry approach on using the performance-based methodology to determine the test interval for the vacuum building. The assessment by CNSC staff on the Bruce Power AMP on concrete containment structures is in progress.

Bruce Power provided all requested information on the materials and components used in the concrete containment structures for systems qualified for seismic loads. CNSC staff

have reviewed this submission and concluded it meets the requirements of CSA standard N287.7.

1B.1.7 Radiation protection

In 2010, Bruce A's performance was "below expectations" and Bruce B's performance was "satisfactory" in the radiation protection SCA.

During refurbishment work in November 2009, in the Bruce A Unit 1 vault, an unforeseen alpha contamination resulted in personnel exposures. It was determined that the ratio of alpha to beta was significantly higher than what is typically encountered in an operating unit. Consequently, the assumption that protecting for beta contamination is sufficient to protect against alpha contamination was determined not to be valid in all instances.

As part of the CNSC's compliance and verification program, CNSC staff conducted a follow up inspection to the alpha contamination event in Bruce A. In February 2010, CNSC staff had conducted an initial reactive inspection. Based on the observations made during an inspection in May 2010, CNSC staff concluded that Bruce Power had taken appropriate corrective actions and is actively following up on this issue.

Pursuant to subsection 12(2) of the GNSCR, a CNSC authorized official issued a request to all NPP licensees to assess and implement immediate compensatory measures to protect workers from alpha hazards. All NPP licensees responded with adequate measures as a result of the 12(2) request.

Following the discovery of alpha contamination on the Bruce A refurbishment project, Bruce Power implemented enhancements to its radiation protection program. Bruce Power also initiated an extent of condition to determine if historical uptakes had occurred in the operating units. This extent of condition work is ongoing and to date no significant issues have been reported by the licensee.

During the Bruce B Unit 6 planned outage, there was a moderator water spill that caused elevated levels of tritium in the plant. The spill was caused by an operations error during a non-routine maintenance activity on the moderator system. The procedure that was used to install a temporary ice plug for isolation of a pipe did not account for the actual moderator system configuration at the time. As a result of the event, some moderator water leaked. About 200 personnel present in the facility at the time were requested to submit bioassay samples. Although none of them exceeded regulatory dose limits, 19 workers exceeded the action level of 2 mSv of dose from tritium uptake.

In response, Bruce B staff initiated a separate RCA to determine why this event resulted in such radiological consequences to non-affected staff and to determine whether any programmatic deficiencies and/or organizational weaknesses exist. The main corrective measures implemented by Bruce Power were to install alarming tritium air monitors and to modify the radiation protection program to trigger evacuation earlier on suspected

tritium events. CNSC staff performed an immediate focused inspection and found that Bruce Power's actions are comprehensive and adequate for the event. This new instrumentation has already been effective in warning station staff of elevated tritium levels due to malfunctioning equipment.

The safety significance of the moderator water spill was considered in the rating of operating performance as indicated in section 1B.1.3.

The 2010 dose information for Bruce A and B is provided in Appendix F.

1B.1.8 Conventional health and safety

Bruce A and B's performance in conventional health and safety remained "fully satisfactory" in 2010.

In 2010, CNSC staff found that both Bruce A and B were compliant with the applicable sections of the *Ontario Occupational Health and Safety Act* and Regulations. Housekeeping/management of hazards in 2010 met CNSC requirements at Bruce A and B. CNSC staff inspections only found minor non-compliances which were always immediately corrected when brought to the attention of the licensee.

The accident severity rate (see section 1A.8 for definition) for Bruce A and B combined for this year, 0.12, remains very low in comparison with other industries.

Bruce Power had achieved about 23 million hours without an acute lost time accident (LTA) in 2010 prior to a LTA that occurring during the last quarter of the year. The Bruce A refurbishment project reached over 10 million hours without an LTA during 2010. In addition, Bruce Power received the 2010 Construction Industry Safety Excellence Award from the Construction Users Roundtable for its safety performance on the refurbishment project.

1B.1.9 Environmental protection

Bruce A and B's performance in environmental protection was "satisfactory" in 2010.

Bruce Power's revised derived release limits (DRLs) are based on new dose calculations, relevant parameters and an updated model. The DRLs are the emissions to the environment that will not result in the public annual dose exceeding the regulatory limit of 1,000 μSv.

In 2010, the reported dose to the public due to both Bruce A and B was 2.9 μSv, which is well below the public dose limit of 1,000 μSv. This continues a trend since the beginning of operation of Bruce A and B, where the actual dose to public is a small fraction of the public dose limit. In addition, gaseous and aqueous releases of nuclear substances were also below the environmental action levels for both stations.

Based on inspections, CNSC staff verified compliance with regulatory requirements in its PROL and determined that Bruce Power adhered to internal procedures related to the radiological environmental monitoring program.

Legal action was taken by Environment Canada for six events that occurred at Bruce A and B in the period of 2008 to 2010. For these events, the Ontario Ministry of the Environment had previously determined that no environmental penalties were warranted. CNSC staff have also reviewed the events and determined that these issues were not risk-significant from a nuclear safety perspective. However, CNSC is monitoring the implementation of corrective actions. The legal action is still before the courts.

1B.1.10 Emergency management and fire protection

Bruce Power's performance in the emergency management and fire protection SCA was rated "satisfactory" in 2010.

Overall, Bruce Power has continued to improve in the areas that were inspected concerning fire protection issues. Bruce Power staff responded to the findings and performed the corrective actions within a reasonable amount of time.

CNSC staff performed an inspection to verify the adequacy of the transportation emergency response plan (TERP). Evaluation of the emergency preparedness program was based on conformance to Bruce Power's radioactive material TERP and the criteria in the applicable sections of CNSC Regulatory Document RD-353, *Testing and Implementation of Emergency Measures*. No directives or action notices were issued as a result of the inspection.

CNSC staff also performed an inspection at the exercise to verify the adequacy of Bruce Power's corporate emergency response plan and the criteria in the applicable sections of CNSC Regulatory Document RD-353. Some minor deficiencies were found and Bruce Power is in the process of correcting them.

Bruce Power has decided to reduce the inventory of new fuel on site to reduce the fire loading of the new fuel storage areas at Bruce A and B stations. In addition other transient combustible materials and fire loading has improved at the site. Bruce Power continues the process of transitioning from the old fire standard CSA N293-95, *Fire Protection for CANDU Nuclear Power Plants*, to the new standard N293-07 and must complete a new code compliance review, fire hazard assessment and fire safe shutdown analysis in accordance with N293-07 by December 2011. CNSC staff are satisfied with the progress made to date in this area.

There was a possibility of work disruption at the Bruce Power. The Labourers' International Union of North America, Local 1059 was in a legal strike position in June 2010. Bruce Power monitored the situation and had produced contingency plans to ensure that duty crews could access the Bruce site in order to maintain shift complements. The disruption did not materialize as there was eventually a contract agreement.

1B.1.11 Waste management

The waste management SCA was rated "satisfactory" in 2010.

Bruce Power has a radioactive waste management program in place that documents requirements for the minimization, segregation, handling, monitoring and processing of radioactive waste. The program requires the assessment of the hazard levels for all radioactive waste. Based on this assessment, all radioactive waste is disposed of appropriately in accordance with regulations and Bruce Power's internal procedures.

In 2010, CNSC staff inspections noted minor areas for improvement in waste minimization, segregation and characterization; however, these findings did not have an effect on the overall effectiveness of the program.

1B.1.12 Security

The performance rating for this SCA is presented to the Commission in a separate Commission Member Document (CMD 11-M46.A).

1B.1.13 Safeguards

The Safeguards SCA at Bruce A and B met applicable CNSC requirements and performance objectives in 2010, and both stations received a "satisfactory" rating.

There has been no change in the stations' performance. Bruce Power has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons*.

The IAEA did not select Bruce A for a physical inventory verification (PIV) in 2010. In its absence, the CNSC conducted a physical inventory taking evaluation, to provide assurance to the IAEA that the facility was properly prepared for a PIV, had it been selected. The CNSC concluded that the licensee met its expectations.

The IAEA conducted a PIV at Bruce B from July 7 to 15, 2010 to verify that no diversion of nuclear material had taken place, to detect any tampering with the IAEA's containment/surveillance system, and to confirm the declarations provided by the state authorities and facility operators. The inspection was attended by CNSC staff, who reviewed the facility's support for IAEA inspectors including: escorts and equipment; the provision of accountancy information and supporting documents; the facility compliance with safeguards licence conditions relevant to the inspection activity; and the IAEA's adherence to its rights and obligations relevant to the inspection. No significant compliance issues were identified.

1B.1.14 Packaging and transport

Bruce A and B's performance in packaging and transport was "satisfactory" in 2010.

CNSC staff did not identify any issues in this SCA from site surveillance activities or S-99 reporting. Available evidence demonstrated that Bruce Power is meeting CNSC requirements and expectations for its packaging and transport program at Bruce A and Bruce B.

1B.2 Darlington

Table 9 presents the performance ratings for Darlington in 2010. All SCAs received "satisfactory" or "fully satisfactory" performance ratings. The 2010 integrated plant rating for Darlington was "fully satisfactory".

There were no serious process failures at Darlington during 2010. No worker or member of the public received a dose in excess of the regulatory dose limits, and all environmental emissions were below regulatory limits and station action levels.

Based on observations and the assessments of the SCAs, CNSC staff conclude that Darlington was operated safely in 2010.

OPG also complied with licence conditions concerning Canada's international safeguards obligations in 2010.

Table 9: Performance Ratings for Darlington for 2010

Safety and Control Area	Rating	Industry Average
Management system	SA	SA
Human performance management	SA	SA
Operating performance	FS	SA
Safety analysis	SA	SA
Physical design	SA	SA
Fitness for service	FS	SA
Radiation protection	FS	SA
Conventional heath and safety	FS	SA
Environmental protection	SA	SA
Emergency management and fire protection	SA	SA
Integrated plant rating	**FS**	**SA**
Waste management*	SA	SA
Security*	Prescribed	Prescribed
Safeguards*	SA	SA
Packaging and transport*	SA	SA

* Waste management, security, safeguards, and packaging and transport were excluded from the integrated plant ratings.

1B.2.1 Management system

Darlington's performance for the management system SCA was rated "satisfactory" for 2010.

OPG has established and implemented a management system per the CSA standard N286-05 for the safe operation of its three NPPs, Darlington, Pickering A and

Pickering B. The documentation describing the implementation of the management system is the same for the three NPPs.

For 2010 the operating licence for Darlington required the implementation of a quality assurance (QA) program per the CSA N286 Series of QA standards (N286.0 through N286.6). The implementation of a management system per CSA standard N286-05 focuses on the management of all systems, equipment and activities and not just those related to safety.

In 2010 the overall QA program document N-CHAR-AS-0002 R012, *Chief Nuclear Officer Expectations*, was revised to N-CHAR-AS-0002 R013, *Nuclear Management System*. CNSC staff concluded that the OPG document contains information to demonstrate that OPG has established and documented a management system. This OPG document in combination with lower-level governance, such as instructions and procedures, meets the requirements of N286-05. As an enhancement over the normal review cycle for program level documents, OPG will be ensuring that the requirements of N286-05 are captured in the higher level documents of N-CHAR-AS-0002 or associated N-PROG programs. OPG submitted another revision to the charter document (R14) which has been accepted by the CNSC. CNSC staff did not identify any deficiencies related to the documented management system that could result in unsafe operating conditions at Darlington.

OPG has continued to develop its ability to conduct self-assessments of safety culture, moving towards developing its own method rather than relying on an outside contractor. The CNSC continues to monitor this development and continues to work with the team at OPG.

Overall, Darlington maintains a management system that integrates provisions to address all regulatory and other requirements to enable the licensee to achieve its safety objectives, continuously monitor its performance against those objectives, and maintain a healthy safety culture.

1B.2.2 Human performance management

Darlington's performance in human performance management was "satisfactory" in 2010.

In 2010, the overall success rate in initial certification examinations at Darlington was 100%. The requalification pass rate was 95%.

Darlington is currently working towards transferring regular maintenance activities to day shifts. Industry's operating experience indicates that such a days-based maintenance program may provide a number of benefits, but its implications must be carefully analyzed by CNSC staff before implementation.

Darlington is also currently working on a project to compare current minimum shift complement numbers and qualifications with the expectations in CNSC Regulatory Guides G-323, *Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement* and G-278, *Human Factors Verification and Validation Plans*.

CNSC staff conducted a Type II inspection and found that Darlington has an adequate process to ensure that minimum shift complement requirements are met each shift. In addition, review of the section on the shift performance of certified staff in the S-99 quarterly operations reports for 2010 confirmed that regulatory requirements related with the minimum shift duty performance of certified staff were adhered to by the licensee.

1B.2.3 Operating performance

Operating performance was rated "fully satisfactory" for Darlington in 2010.

Throughout the year, CNSC staff conducted numerous inspections, including field and control room inspections. Darlington conducted its activities such that plant operation are safe and secure with adequate regard for health, safety, security, radiation and environmental protection and international obligations.

There were no significant operations-related issues identified. Darlington continues to demonstrate a high degree of compliance in this area.

During 2010, CNSC staff performed a focused inspection into an event on Unit 4 where an adjuster rod spuriously drove out-of-core. OPG control room staff actions in response to the event were consistent with prescribed procedures, and the unit was placed in low-power. OPG discovered that the design of the logic module in the adjuster assembly caused the withdrawal of the adjuster rod when the associated power supply failed. It was discovered that the power supplies on Unit 3 and 4 were not as reliable as those installed in Unit 1 and 2. OPG initiated interim mitigating measures to replace the existing power supplies with more reliable power supplies. OPG is currently seeking long-term mitigating measures to reduce the likelihood or prevent recurrence of this event.

Darlington's operational activities are established by the licensee's document NK38-OPP-03600, *Operating Policies and Principles* (OP&Ps), as referenced by the PROL. This document governs how Darlington will operate, maintain and modify station systems to maximize nuclear safety and keep the consequential risk to the public acceptably low. It defines the applicable boundaries of the safe operating envelope. In 2010, Darlington continued to operate within the safe operating envelope. The four reactor units operated within the reactor power limits prescribed by the Darlington operating licence and the facility staff submitted regularly scheduled and unscheduled reports as prescribed by CNSC standard S-99, *Reporting Requirements for Operating Nuclear Power Plants.*

There were two planned maintenance outages and two unplanned outages. Darlington's outage management conforms to the conditions prescribed by the Darlington operating licence and all outage-related undertakings have been conducted safely. Since 2009, CNSC has given Darlington conditional approval to restart in order to prevent the possibility of administrative delays. As of 2010, after completing two planned single-unit outages and a multi-unit outage under this agreement, Darlington has been in compliance with the conditions of the approvals and will be permitted to continue with this arrangement.

Darlington experienced one trip, one setback and no stepbacks in 2010.

COG is the main external interface for OPG to obtain and submit OPEX information. Once the information is obtained it is evaluated by OPG staff for significance and relevancy to their operations and acted upon as required. The information and evaluations remain available to OPG staff to be used when planning and performing their tasks. OPG stations have databases to collect information regarding identified problems. The information from these databases are reported and trended on an ongoing basis.

The collection of internal OPEX information for Darlington is integrated into their problem identification processes. Staff at all levels can input information into and obtain information from the problem identification databases. The OPG OPEX Type I inspection reported to OPG in August 2010 did not identify deficiencies related to the use of OPEX information.

Darlington continues to submit scheduled reports as required by CNSC Regulatory Document S-99, *Reporting Requirements for Operating Nuclear Power Plants*. There were no significant issues with these reports during 2010.

Tritium removal facility

Darlington is the only NPP in the CANDU fleet that maintains and operates a tritium removal facility (TRF). Tritium is a radioactive by-product that gradually builds up as a result of day-to-day operations of CANDU reactors. The TRF is designed to minimize the amount of tritium released into the environment, as well as reduce the potential radiation exposure of the workers. The TRF extracts tritium from the heavy water used in the

reactors. The extracted tritium is then safely stored in stainless steel containers within a concrete vault. The operation of the TRF did not exceed any environmental limits in 2010.

1B.2.4 Safety analysis

Darlington's performance in safety analysis was "satisfactory" in 2010.

Darlington appropriately demonstrated acceptability of the consequences and/or frequency of a wide range of internal and external events. For design basis events and accidents, Darlington's safety analysis safety performance adequately presented the capability of protective systems to adequately control power, cool the fuel and contain the radioactivity that could be released from the plant. Darlington's probabilistic safety assessment that accounts for beyond design basis accidents demonstrates that overall plant risk is acceptably low.

OPG continues to make satisfactory progress in resolving a number of on-going safety analysis programs or topics, such as, safety analysis improvement (SAI) program, safe operating envelope, impact of plant aging on safety analysis, resolution of category 3 CANDU safety issues and compliance with CNSC Standard S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*.

On September 27, 2010, OPG submitted the results of an impact assessment of recent research findings on an analysis of a postulated irradiated fuel port (IFP) accident scenario documented in Darlington's safety report. The research findings concerned the oxidization rate of zircaloy in air. CNSC has requested OPG to provide additional information to demonstrate that the current safety report analysis bounds the radiological impact of the IFP scenario in light of the new research findings; this will be provided by June 30, 2011.

1B.2.5 Physical design

In 2010, Darlington's overall performance in physical design was rated "satisfactory".

Darlington adequately confirmed that SSCs important to nuclear safety and security continued to meet their design basis in all operational states until the end of their design lives.

OPG completed an improvement project to comply with the EQ program as required by the Darlington operating licence. All required systems, equipment, components, protective barriers and structures in Darlington are fit for service to perform their safety functions under prescribed conditions. Darlington continues to work on EQ project deliverable activities above and beyond requirements for EQ compliance.

CNSC staff conducted several desktop reviews of human factors documentation submitted in support of engineering change control-based design modifications. Although

the submissions were satisfactory, some weaknesses were noted in the planning and scheduling of human factors work, in its integration within the overall engineering design change, and in the rigour of documenting the work performed.

CNSC staff provided feedback to OPG on the basis document governing the integrated safety review (ISR) being conducted in support of plant life extension at Darlington. The revised document was re-submitted and was accepted by CNSC staff in December 2010.

Consequently, OPG has established and implemented graded processes for the development, installation, and commissioning of design changes to SSCs of its three NPPs. The processes evaluate the risk to safe operation of the change being made. The evaluation considers whether the equipment is safety related or not, the scope regarding the number of departments to be involved, regulatory requirements, and technical complexity.

1B.2.6 Fitness for service

Darlington was rated "fully satisfactory" for its performance in the fitness for service SCA in 2010.

This is an improvement from 2009 where fitness for service was rated as "satisfactory".

Darlington's performance was highly effective in meeting the objective of this SCA; the SSCs remained available, reliable and effective, consistent with the design, analysis, and quality control measures.

As per the requirements of CSA standards N286.1 and N286-05, vendors used for the procurement of items and services are required to implement an adequate quality assurance program. To ensure this, OPG is required to periodically perform audits on those vendors. In 2010, CNSC staff reviewed OPG documentation for the controls implemented on its vendors and determined that they adequately provide the assurance that an adequate quality assurance program has been implemented.

With respect to periodic inspections of pressure boundary components, containment components and containments; OPG has fulfilled all requirements associated with licence condition 5.2 (c) and CSA standards N285.4, *Periodic Inspection of CANDU Nuclear Power Plant Components,* N285.5, *Periodic Inspection of CANDU Nuclear Power Plant Containment Component,* and N287.7, *In-service Examination and Testing Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants*, as well as the recent initiation of additional research on the fuel channel life management project (FCLMP). The latter is a research project that OPG, Bruce Power and AECL have initiated to demonstrate that the fuel channel (FC) materials are safe to operate beyond the assumed design limit of 210,000 equivalent full-power hours (i.e., 30 years at 80% power). OPG has a comprehensive feeder life cycle management program that is updated yearly. The *Feeder Fitness for Service Guidelines*, Revision 2, was developed through a

COG research program and CNSC staff approved its use at all OPG units for a trial period of two years.

Darlington's performance in maintenance remained consistent with the previous year and the PMCR exceeded the station target. Darlington experienced challenges with their fuelling machine which did not have a safety significant impact on the station operation.

OPG's reliability program was accepted prior to 2010, and since acceptance of the program there have been no outstanding issues. The annual reliability report for 2010 is acceptable.

OPG inspects and tests pressure retaining and containment systems, structures and components, in accordance with the station PIP and applicable CSA standards. No significant findings related to pressure boundary degradation were identified during the 2010 inspection campaign. Darlington has fitness for service programs in place to ensure the integrity of pressure tubes, feeders, and steam generators are maintained.

OPG has demonstrated above average performance with respect to ensuring the health of the pressure tubes in these units. OPG has also responded positively to CNSC staff's recommendation to use a newly developed tool during their inspection outages to measure the gap between the pressure tubes (PTs) and calandria tubes (CTs), in order to ensure there is no PT/CT contact in Darlington FCs equipped with tight-fitting spacers. A substantial portion of the FCLMP is devoted to demonstrating the structural integrity of tight-fitting spacers to the end of operating life. In particular substantial effort is being spent to ensure that the tight-fitting garter spring spacers in Darlington units can perform their design function, namely remain at the correct axial location and withstand operational loads without losing their integrity.

OPG adheres to the maintenance activities required by applicable standards referenced in the licence. The in-service inspections performed exceeded the periodic inspection requirements set by the CSA Standard N285.4.

As part of the on-going discussion between the industry and CNSC on utilizing the performance-based approach available in CSA N287.7-08 standard for the determination of the inspection and testing frequency for the vacuum buildings, OPG submitted the common industry approach to use the performance-based methodology to CNSC staff for review and acceptance. In the submission, OPG included the station updated periodic inspection programs for CSA N287.7 and the AMP for concrete containment structures to CNSC staff for review and acceptance.

1B.2.7 Radiation protection

Darlington was rated "fully satisfactory" for its performance in the radiation protection SCA in 2010.

This is an improvement from 2009 where radiation protection was rated as "satisfactory". This change is based on the collective findings from inspections, desktop reviews and new initiatives performed in 2010.

Darlington protected the health and safety of persons inside the facility through the implementation of a radiation protection program which ensures that occupational exposures are below regulatory dose limits and is optimized and maintained ALARA.

Throughout 2010, Darlington was highly effective in controlling unplanned worker radiological-uptakes and using OPEX to achieve industry best practice. The three year collective doses are trending downward and the internal dose was reduced in 2010 compared with previous years due to a number of initiatives implemented to reduce tritium source term. OPG was proactive in using OPEX to recognize alpha hazards and implement programmatic improvements to provide protection to workers in all operating units.

The dose information for Darlington is provided in Appendix F. In the reporting period, there have been no radiation exposures that exceeded regulatory limits and no incidents resulting in doses in excess of OPG's internal action levels reported to the CNSC. OPG continues to work on implementing enhanced radiation protection program requirements related to alpha monitoring and control. CNSC staff concludes that OPG has implemented sufficient measures to protect workers against alpha hazards and has demonstrated a commitment to implementing long-term radiation protection program enhancements to monitor and control alpha hazards. OPG continues to enhance this program to align with industry best practices.

No significant issues have been identified in this reporting period.

1B.2.8 Conventional health and safety

Darlington's performance in this SCA was "fully satisfactory" in 2010.

Darlington's conventional health and safety work practices and conditions achieved a high degree of personnel safety.

The accident severity rate (see section 1A.8 for definition) for this year, 1.64, remains low relative to other industries. There were 43 person-days lost at the station due to disabling injuries. Darlington continues to adhere to applicable labour codes (e.g., regular inspections of their scaffolding) and maintains good housekeeping.

No significant issues have been identified in this reporting period.

1B.2.9 Environmental protection

In 2010, Darlington's overall performance in the environmental protection SCA was rated as "satisfactory".

During the same period gaseous and aqueous releases of nuclear substances were always below environmental action levels and derived release limits. The reported dose to the public from Darlington in 2010 was 0.6 μSv, which is well below the public dose limit of 1,000 μSv.

As the result of environmental protection inspections and assessments carried out in 2010, no new significant issues have been identified in this reporting period.

1B.2.10 Emergency management and fire protection

Darlington's overall performance in emergency management and fire protection was "satisfactory" for 2010.

In 2009 the rating for the previous safety area of emergency preparedness for Darlington was "fully satisfactory". As the emergency management and fire protection SCA now covers both the emergency response and fire protection requirements, the change from 2009 to 2010 does not necessarily reflect a reduction in performance in emergency response but rather the results of the combination of the two requirements, emergency response and fire protection.

Darlington has sufficient provisions for preparedness and response capability that would mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of national security.

Darlington implemented a comprehensive fire protection program to minimize the risk to the health and safety of persons and to the environment from fire, through appropriate fire protection system design, fire safety analysis, fire safe operation and fire prevention.

No significant issues have been identified in this reporting period.

1B.2.11 Waste management

Darlington's waste management SCA performance rating was "satisfactory" in 2010.

Darlington has appropriately developed, implemented, and audited its facility and waste stream-specific waste management program to control and minimize the volume of radioactive waste generated by the licensed activity. The licensee has also included waste management as a key component of its corporate and safety culture and maintained a preliminary decommissioning plan (PDP).

Darlington has a nuclear waste management program to minimize, control and properly dispose of radioactive waste. OPG's Nuclear Waste Management Division has implemented a new electronic radiological log to track contamination and radiation surveys completed at the facility. This system is being used at each of OPG's nuclear stations. Radioactive wastes are controlled, monitored and releases are recorded.

Currently, Darlington is in the process of implementing corrective actions as a result of findings from a Type II inspection.

The Darlington PDP meets the requirements of CNSC Regulatory Guide G-219, *Decommissioning Planning for Licensed Activities*.

No significant issues have been identified in this reporting period.

1B.2.12 Security

The performance rating for this SCA is presented to the Commission in a separate Commission Member Document (CMD 11-M46.A).

1B.2.13 Safeguards

The safeguards SCA at Darlington met applicable CNSC requirements and performance objectives in 2010, and received a "satisfactory" rating.

There has been no change in the station's performance. OPG has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons*.

The IAEA did not select Darlington for a PIV in 2010. In its absence, the CNSC conducted a physical inventory taking evaluation to provide assurance to the IAEA that the facility was properly prepared for a PIV, had it been selected. No significant compliance issues were identified.

In addition, OPG provided support for extensive IAEA equipment installations and upgrades during the year.

1B.2.14 Packaging and transport

Darlington's packaging and transport SCA was rated "satisfactory" in 2010.

This SCA pertains to programs that cover the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility. Based on site-surveillance activities and S-99 reporting, CNSC staff did not identify any significant issues regarding the packaging and transport in 2010.

1B.3 Pickering A

Table 10 presents the performance ratings for Pickering A in 2010. All SCAs received "satisfactory" performance ratings. The 2010 integrated plant rating for Pickering A was "satisfactory".

There were no serious process failures at Pickering A during 2010. No worker or member of the public received a dose in excess of the regulatory dose limits, and all environmental emissions were below regulatory limits and station action levels.

Based on these observations and the assessments of the SCAs, CNSC staff conclude that Pickering A was operated safely in 2010.

OPG also complied with licence conditions concerning Canada's international safeguards obligations in 2010.

Table 10: Performance Ratings for Pickering A for 2010

Safety and Control Area	Rating	Industry Average
Management system	SA	SA
Human performance management	SA	SA
Operating performance	SA	SA
Safety analysis	SA	SA
Physical design	SA	SA
Fitness for Service	SA	SA
Radiation protection	SA	SA
Conventional heath and safety	SA	SA
Environmental protection	SA	SA
Emergency management and fire protection	SA	SA
Integrated plant rating	SA	SA
Waste management*	SA	SA
Security*	Prescribed	Prescribed
Safeguards*	SA	SA
Packaging and transport*	SA	SA

* Waste management, security, safeguards, and packaging and transport were excluded from the integrated plant ratings.

1B.3.1 Management system

Pickering A's performance in this SCA was "satisfactory" for 2010. This improvement is attributed to OPG's progress in resolving safety culture issues.

OPG has established and implemented a management system per the CSA standard N286-05 for the safe operation of their three NPPs, Darlington, Pickering A and

Pickering B. The documentation describing the implementation of the Management System is the same for the three NPPs.

In 2010 the overall quality assurance program document N-CHAR-AS-0002 R012, *Chief Nuclear Officer Expectations*, was revised to N-CHAR-AS-0002 R013, *Nuclear Management System*. CNSC staff concluded that the OPG document contains information to demonstrate that OPG has established and documented a management system and in combination with lower-level governance, such as instructions and procedures, meets the requirements of N286-05. OPG submitted another revision to the charter document (R14) and is accepted by the CNSC.

Changes have been made to the OPG organization and management system documentation that affect Pickering A. The changes have been communicated to and reviewed by CNSC staff. In 2010 no deficiencies related to these changes were identified.

1B.3.2 Human performance management

Human performance management at Pickering A was rated "satisfactory" in 2010.

This is an improvement when compared to the 2009 rating of "below expectations" in the predecessor safety program of "human factors". This improvement is attributed to OPG's progress in resolving minimum complement issues at Pickering A and B. See section 2.3.3, "Updates on significant regulatory issues," for details.

A pilot inspection of the simulator-based initial certification examination was performed in 2010. OPG performed acceptable corrective actions.

The minimum shift complement requirements were established to ensure that licensees have on-site, at all times, a sufficient number of appropriately qualified staff for both normal operation and to respond to all accident conditions. Recently, minimum complement requirements have been confirmed by OPG to the satisfaction of the CNSC staff through extensive simulator and validation exercises.

Like the other OPG stations, Pickering A is also currently working towards transferring regular maintenance activities to day shifts. More details on this activity are provided in Darlington's section 1B.2.2.

CNSC staff are satisfied that Pickering A has sufficient staff in all relevant job areas and has the necessary knowledge, skills, procedures and tools in place to safely carry out its duties. There were no significant issues resulting from inspections of the training programs in 2010.

In 2010, the overall success rate in initial certification examinations at Pickering A was 100%. The requalification pass rate was 100%.

1B.3.3 Operating performance

Pickering A's performance in operating performance was "satisfactory" in 2010.

Overall, Pickering A generally operated safely throughout 2010.

The annulus gas system leak rate reached 19.7 L/min, which is very close to the safety analysis limit of 20 L/min. OPG responded by lowering the system pressure and removing oxygen addition.

The Unit 1 liquid zone control system zones 5 and 12 have exhibited anomalous behaviour, namely, chronically low level operation relative to other zones, and a higher drop rate in level compared to other zone pairs. The liquid zone control system is part of the reactor regulating system. OPG has performed reviews of the behaviour but has not found the root cause of the anomalous behaviour. OPG will continue to monitor the behaviour of these zones.

The once-in-a-decade vacuum building outage (VBO) was completed successfully and on time (the first unit, Unit 6, restarted two days ahead of schedule). However, there were some issues with the emergency service water piping within the pressure relief duct. Two supports were found to have missing anchor bolts. OPG provided analysis to show that the supports were adequate without the bolts. There remain concerns with proper disposition of these items and the configuration management. OPG has submitted calculations that CNSC staff are reviewing. A planned outage on Unit 1 followed the VBO.

In addition, there were several deratings and shutdowns due to fuelling machine unavailabilities and liquid zone control anomalies. The deratings and shutdowns contributed to relatively low capacity factors – 75% for Unit 1 and 88% for Unit 4.

Overall, outages were conducted safely and in accordance with documented and controlled procedures.

During 2010, Pickering A experienced six spurious reactor trips, no stepbacks, and one setback.

OPG continues to report events to CNSC staff in accordance with S-99, *Reporting Requirements for Operating Nuclear Power Plants*. Since 2008, there has been a noticeable improvement in the timeliness of preliminary reports and reduction in the number of additional reports. OPG is still working to improve their root cause analysis process and corrective action effectiveness.

1B.3.4 Safety analysis

Pickering A's performance in this SCA continues to be rated as "satisfactory" for 2010.

Pickering A has made adequate progress in a number of on-going safety analysis programs including safety analysis improvement, safe operating envelope, impact of plant aging on safety analysis, resolution of category 3 safety issues, and their transitions to compliance with CNSC standard S-294.

Updates on many of the issues common to all or most NPP licensees are discussed in section 1A.4.

1B.3.5 Physical design

Pickering A's performance in this SCA was rated as "satisfactory" for 2010.

This is an improvement in performance as physical design was rated "below expectations" for Pickering A in 2009, due to deficiencies with the temporary inter-station transfer bus modifications. A permanent modification was installed during the VBO beginning in April 2010.

An inspection of the environmental qualification program was performed in 2010. There were no major issues identified.

1B.3.6 Fitness for service

Pickering A's performance in this SCA was "satisfactory" in 2010.

In 2010, Pickering A met its short-term maintenance backlogs targets for corrective maintenance and elective maintenance:

- Corrective maintenance was 9, versus a target of 10 work orders per unit.
- Elective maintenance was 277, versus a target of 350 work orders per unit.

The PMCR has been improving at Pickering A over the past four years, and is currently at 95%.

OPG inspects and tests pressure retaining and containment systems, structures and components in accordance with the station PIP and applicable CSA standards. No significant findings related to pressure boundary degradation at Pickering A were identified during the 2010 inspection campaign. OPG is adhering to its plan for transition to the 2008 edition of N285.5.

There were also no significant findings identified from CNSC staff reviews of Pickering A S-99 operations and pressure boundary reports submitted in 2010.

The Pickering VBO included the inspection and pressure test of the vacuum building and pressure relief duct and their components as well as the inspection and dousing test of the dousing system inside the vacuum building. OPG relocated the containment boundary from the Units 2 and 3 reactor buildings to the Units 2 and 3 bulkheads at the pressure relief duct. In addition, the Unit 1 reactor building was pressure tested.

CNSC staff conducted an inspection on the implementation of PIPs for CSA N285.4 and N285.5. CNSC staff found that, in general, OPG's implementation of the PIPs for the plant's nuclear power plant components and nuclear power plant containment components was satisfactory.

All special safety systems at Pickering A met their unavailability targets in 2010.

1B.3.7 Radiation protection

Pickering A's performance in radiation protection was rated "satisfactory" for 2010.

Based on the assessments of findings in this area, CNSC staff are satisfied that OPG provided adequate protection of the health and safety of persons at Pickering A with respect to ionizing radiation.

The 2010 dose information for Pickering A is provided in Appendix F. In 2010, there were no radiation exposures at Pickering A that exceeded regulatory limits, and no incidents resulting in reportable dose in excess of OPG's action levels.

No significant issues were raised as a result of radiation protection inspections or assessments carried out in 2010.

During 2010, a corrective action plan was developed and being implemented to bring Pickering A's alpha monitoring program up to the industry best practices in this field, including supplemental RP measures for outages and the safe storage project.

1B.3.8 Conventional health and safety

Pickering A's performance in conventional health and safety continues to be rated "satisfactory" for 2010.

No major non-compliances with the applicable labour code were reported in 2010.

Compliance with space allocation and transient materials continues to be an issue.

The accident severity rate (see section 1A.8 for the definition) reported for Pickering A and B combined was 0.71 in 2010, which is very low in comparison with other industries.

Pickering A continues to demonstrate an adequate degree of personnel safety through its occupational health and work practices and conditions.

Pickering A and Pickering B combined only had three disabling injuries – a Pickering A employee who slipped in the parking lot and two cafeteria contractors who were injured in the cafeteria.

CNSC staff concluded overall housekeeping performance was acceptable, but noted a few problems in improper storage of equipment or materials and deficiencies in adherence to the "control of transient material and space allocation" procedure. OPG has implemented an action plan to address these deficiencies. CNSC staff will continue to monitor these activities through quarterly inspections.

1B.3.9 Environmental protection

Pickering A's performance in environmental protection in 2010, is rated "satisfactory". This is attributed to the continuation of the measures OPG has taken to reduce fish mortality at both Pickering A and B.

In previous NPP Reports, the environmental effects of the condenser cooling water system—specifically, fish mortality due to impingement and entrainment—at Pickering A and B was raised as a major issue. This has resulted in OPG installing a barrier net. This is further described in section 2.3.2, "Updates on Major Projects and Initiatives".

No new significant issues were raised as a result of environmental protection inspections or assessments carried out in 2010.

The reported dose to the public from Pickering A and B (combined) in 2010 was 1.0 μSv, which is well below the public dose limit of 1,000 μSv. Gaseous and aqueous releases of nuclear substances were always below environmental action levels and derived release limits.

1B.3.10 Emergency management and fire protection

Emergency management and fire protection at Pickering A continues to be rated "satisfactory" in 2010.

CNSC conducted evaluations of two emergency drills at Pickering in 2010. During both drills, OPG demonstrated their preparedness and competence in dealing with a simulated accident with compounding external events, exchange of information at the federal, provincial and local level and contaminated causality treatment and handling.

Under the provincial nuclear emergency response plan, a public alerting system is required that is capable of alerting everyone within 3 km of the station. Five additional sirens are still required to meet the standard. Installation of these sirens will be completed by May 2011. CNSC staff will continue to monitor the installation and testing of the sirens.

CNSC staff's review of inspection findings, surveillance monitoring and S-99 reportable events for 2010 did not identify any significant issues relating to emergency preparedness. The performance indicators used to evaluate implementation of the emergency management response plan remained steady or, in some cases, improved throughout 2010.

1B.3.11 Waste management

The waste management SCA was rated "satisfactory" in 2010.

OPG's project to place Units 2 and 3, which will not be restarted, into safe storage, was completed in 2010. This is further described in section 2.3.2, Updates on Major Projects and Initiatives.

Pickering A's preliminary decommissioning plan meets the requirements of the applicable Regulatory Guide, G-219, *Decommissioning Planning for Licensed Activities*.

An inspection of non-radioactive hazardous waste management was conducted in October, and found that OPG is in compliance with regulatory requirements for the management of non-radioactive hazardous waste at Pickering.

1B.3.12 Security

The performance rating for this SCA is presented to the Commission in a separate Commission Member Document (CMD 11-M46.A).

1B.3.13 Safeguards

The Safeguards SCA at Pickering A met applicable CNSC requirements and performance objectives in 2010, and received a "satisfactory" rating.

There has been a minor change in the station's performance but this did not result in a change in the SCA rating in comparison to last year's performance. OPG has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons*.

The IAEA conducted a PIV at Pickering A and B during the period October 26 to 29, 2010, with a follow-up visit during the period January 10 to 13, 2011, to verify that no diversion of nuclear material had taken place, to detect any tampering with the IAEA's containment/surveillance system, and to confirm the declarations provided by the state authorities and facility operators. The inspection was attended by CNSC staff, who reviewed the facility's support for IAEA inspectors including: escorts and equipment; the provision of accountancy information and supporting documents; the facility compliance with safeguards licence conditions relevant to the inspection activity; and the IAEA's

adherence to its rights and obligations relevant to the inspection. No significant compliance issues were identified.

During the scheduled IAEA PIV at the Pickering Nuclear Generating Station, Pickering staff notified the CNSC of the impaired state of an irradiated fuel basket hoist. Neither the CNSC nor the IAEA were informed of the difficulties in accessing nuclear material due to the fuel basket hoist impairment prior to the start of the inspection. The IAEA was unable to complete its inspection until repairs were complete in January due to the amount of nuclear material unavailable for verification. Pickering staff have been reminded that any situation or incident that could interfere with safeguards implementation should be immediately brought to the attention of the CNSC and the IAEA. While the absence of notification did not significantly impact the facility's rating in 2010, CNSC staff will closely monitor compliance in 2011.

1B.3.14 Packaging and transport

The packaging and transport SCA at Pickering A was rated "satisfactory" in 2010.

No significant issues were identified regarding packaging and transport in 2010.

CNSC staff expect that the licensee will continue to operate in accordance with its radioactive material transport program as described in the OPG document W-PROG-WM-0002, *Radioactive Material Transportation*. This program describes controls that ensure safe, compliant, and efficient radioactive materials transportation. It also includes verification that the transportation emergency response plan is appropriately established.

1B.4 Pickering B

Table 11 presents the performance ratings for Pickering B in 2010. All SCAs received "satisfactory" performance ratings. The 2010 integrated plant rating for Pickering B was "satisfactory", the same integrated plant rating as received by this licensee in 2009.

There were no serious process failures at Pickering B during 2010. No worker or member of the public received a dose in excess of the regulatory dose limits, and all environmental emissions were below regulatory limits.

Based on observations and the assessments of the SCAs, CNSC staff conclude that Pickering B was operated safely in 2010.

OPG also complied with licence conditions concerning Canada's international safeguards obligations in 2010.

Table 11: Performance Ratings for Pickering B for 2010

Safety and Control Area	Rating	Industry Average
Management system	SA	SA
Human performance management	SA	SA
Operating performance	SA	SA
Safety analysis	SA	SA
Physical design	SA	SA
Fitness for service	SA	SA
Radiation protection	SA	SA
Conventional heath and safety	SA	SA
Environmental protection	SA	SA
Emergency management and fire protection	SA	SA
Integrated plant rating	SA	SA
Waste management*	SA	SA
Security*	Prescribed	Prescribed
Safeguards*	SA	SA
Packaging and transport*	SA	SA

* Waste management, security, safeguards, and packaging and transport were excluded from the integrated plant ratings.

1B.4.1 Management system

Pickering B's performance in this SCA was rated "satisfactory" for 2010.

OPG has established and implemented a management system per the CSA standard N286-05 for the safe operation of its three NPPs, Darlington, Pickering A and Pickering B. The documentation describing the implementation of the management system is the same for the three NPPs.

For 2010 the operating licence for the Pickering B NPP required the implementation of a quality assurance (QA) program per the CSA N286 Series of QA standards (N286.0 through N286.6). The implementation of a management system per CSA standard N286-05 focuses on the management of all systems, equipment and activities not just those related to safety.

In 2010 the overall quality assurance program document N-CHAR-AS-0002 R012, *Chief Nuclear Officer Expectations*, was revised to N-CHAR-AS-0002 R013, *Nuclear Management System*. CNSC staff conclude that the OPG document contains information to demonstrate that OPG has established and documented a management system and in combination with lower-level governance, such as instructions and procedures, meets the requirements of N286-05. OPG submitted another revision to the charter document (R14) and is accepted by the CNSC.

Changes have been made to the OPG organization and management system documentation that affect Pickering B. The changes have been communicated to and reviewed by CNSC staff. In 2010, no deficiencies related to these changes were identified.

1B.4.2 Human performance management

Human performance management at Pickering B improved to "satisfactory" in 2010.

This is an improvement when compared to the 2009 rating of "below expectations" in the predecessor safety program of "human factors". This improvement is attributed to OPG's progress in resolving minimum complement issues at Pickering A and B. See section 2.4.3, "Updates on significant regulatory issues," for details.

There were a series of incidents where the limits to the hours-of-work were exceeded and a few occasions where minimum complement was not met during 2010. These incidents had no impact on plant safety. OPG has undertaken actions to provide coaching and to increase awareness to their staff on hours-of-work as well as minimum complement requirements to minimize these non-compliances.

Like the other OPG stations, Pickering B is also currently working towards transferring regular maintenance activities to day shifts. More details on this activity are provided in Darlington's section 1B.2.2.

CNSC staff are satisfied that Pickering B has sufficient staff in all relevant job areas with the necessary knowledge, skills, procedures and tools in place to safely carry out their duties. There were no significant issues resulting from inspections of the training, examination and certification programs in 2010.

In 2010, the overall success rate in initial certification examinations at Pickering B was 86%. The requalification pass rate was 90%.

1B.4.3 Operating performance

Pickering B's performance in operating performance was "satisfactory" in 2010.

CNSC staff conducted numerous inspections in 2010, including field and control room inspections. No significant operations-related issues were identified.

During 2010, Pickering B experienced eight unplanned outages, one trip, one stepback, five setbacks, and no serious process failures. There were also five maintenance planned outages. Overall, the outages were conducted safely.

1B.4.4 Safety analysis

Pickering B's performance in this SCA was rated "satisfactory" for 2010. Updates on many of the issues common to all or most NPP licensees are discussed in section 1A.4.

Safety report update

Regulatory requirement, pursuant to standard S-99, *Reporting Requirements for Operating Nuclear Power Plants* requires an update of the safety report in every three-year period. Monitoring and compliance activities are currently the subject of on-going discussions between OPG and CNSC staff. The next safety report update for Pickering B is due for submission during fall 2011. CNSC staff will continue to monitor OPG's progress on the safety report update.

Probabilistic safety assessment

Probabilistic safety assessment (PSA) for a nuclear power plant is a comprehensive and integrated assessment of the safety of the plant or reactor. The PSA considers the probability, progression and consequences of equipment failures or transient conditions to derive numerical estimates that provide measure of the safety of the plant or reactor, and are delineated by levels of assessment. Level 1 PSA identifies and quantifies the sequence of events that may lead to the loss of core structure integrity and massive fuel failure. A Level 2 PSA starts from Level 1 results, and analyses the containment behaviour, evaluates and quantifies the releases from the failed fuel to the environment.

OPG is required under the licence to update the Pickering B probabilistic risk assessment to fully comply with CNSC document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*, by December 31, 2012. OPG is currently updating the Pickering B

at power Level 1 PSA. Compliance with S-294 implies the development of PSA for all modes of operation as well as the inclusion of external events such as fire, flood and seismic.

CNSC staff reviews of the PSA methodologies for Pickering B led to the acceptance of the following:

- at-power Level 1 PSA internal events
- outage Level 1 PSA internal events
- Level 2 PSA

The methodologies for Level 1 external events (fire, flood, and seismic) are currently under review and this review is expected to be completed in December 2011.

CNSC staff will continue to monitor progress on the Pickering B probabilistic risk assessment and track its implementation.

1B.4.5 Physical design

The physical design SCA was rated "satisfactory" in 2010. There were no significant issues identified in this area in 2010.

In 2010, modifications to the design or equipment of the existing nuclear facility at Pickering B were made in accordance with the existing applicable codes, standards, regulations, and licence conditions. It is expected that funding for minor modifications will increase for continued operations to deal with emergent obsolescence issues.

There were no significant issues identified in the equipment qualification program at Pickering B in 2010.

1B.4.6 Fitness for service

Pickering B's performance in the fitness for service SCA was "satisfactory" in 2010. CNSC staff inspections and assessments did not identify any significant maintenance-related issues.

In 2010, OPG met its short-term maintenance backlogs targets for corrective maintenance and elective maintenance:

- Corrective maintenance was 22.5, versus a target of 25 work orders per unit.
- Elective maintenance was 480, versus a target of 500 work orders per unit.

The Pickering B elective maintenance backlog target is high, compared to best industry practices. OPG continues to provide quarterly status update until the elective maintenance backlog at Pickering B is reduced to the committed long-term target of 300 to 400 work

orders per unit. CNSC staff will continue to monitor this progress in 2011, through normal follow-up activities.

OPG inspects and tests pressure retaining and containment systems, structures and components in accordance with the station PIP and applicable CSA standards. No significant findings related to pressure boundary degradation at Pickering B were identified during the 2010 inspection campaign.

There were also no significant issues identified from CNSC staff reviews of Pickering B S-99 operations and pressure boundary reports submitted in 2010.

In 2010, the inspection and pressure test reports for Unit 8 reactor building were submitted to CNSC for review and acceptance. Assessment by CNSC staff was completed and review comments were provided to OPG.

Pickering B has satisfactorily performed and reported periodic inspections of containment components according to the CSA N285.5 and S-99 respectively.

Regarding the transition to the new 2008 standard, OPG have submitted a transition plan to the new standard during 2010. So far Pickering B is adhering to the transition plan time lines, which scoped end of 2012 as completion date.

OPG submitted an aging management plan for concrete containment structures for CNSC review in mid-2010. CNSC comments on the aging management plan were provided to OPG in late 2010. The Pickering B nuclear generating station (NGS) also updated the PIPs to meet the requirements of CSA N287.7-08 standard.

CNSC staff accepts that all feeders in Pickering Unit 7 are fit for continued service to the next planned outage. In addition, all Pickering B feeders, except a small number of inaccessible feeders, have completed baseline thinning inspection.

All special safety systems at Pickering B met their unavailability targets in 2010.

The OPG reliability report noted significant failure rates changes for the emergency power system. The main contributors to these changes were start failures of the emergency power generators, due to control problems. OPG has committed to upgrade the controls for the generators by early 2012.

Over the past few years, there have been a number of correspondences on Pickering B emergency service water (ESW) issues between OPG and CNSC. In 2010, CNSC staff conducted an inspection of the ESW and concluded that OPG has adequately addressed all CNSC staff issues. In addition, CNSC staff approved the revised ESW pump availability requirements.

In 2010, Pickering B experienced two emergency low-pressure service water pump shaft failures. Both pump shafts were repaired shortly after the failure. OPG is investigating the root cause for these failures.

1B.4.7 Radiation protection

Radiation protection at Pickering B was rated "satisfactory" in 2010.

Based on the assessments of findings in this area, CNSC staff is satisfied that OPG provided adequate protection of the health and safety of persons at Pickering B with respect to ionizing radiation.

The 2010 dose information for Pickering B is provided in Appendix F. In 2010, there were no radiation exposures at Pickering B that exceeded regulatory dose limits, and no incidents resulting in reportable dose in excess of OPG's action levels.

No significant issues were raised as a result of RP inspections or assessments carried out in 2010.

OPG's alpha monitoring program has been revised to match the current industry best practices in this field (EPRI standard) and implemented work control measures to mitigate potential alpha exposures for fuel handling workers at Pickering B as a result of the OPEX at Bruce Power.

1B.4.8 Conventional health and safety

This SCA was rated "satisfactory" for Pickering B in 2010.

The accident severity rate (see section 1A.8 for the definition) reported for Pickering A and B combined was 0.71 in 2010, which is very low in comparison with other industries.

Pickering B continues to demonstrate an adequate degree of personnel safety through its occupational health and work practices and conditions.

Pickering A and Pickering B combined only had three disabling injuries–a Pickering A employee who slipped in the parking lot and two cafeteria contractors who were injured in the cafeteria.

CNSC staff concluded overall housekeeping performance to be acceptable, but noted a few problems in improper storage of equipment or materials and deficiencies in adherence to the "control of transient material and space allocation" procedure. OPG has implemented an action plan to address these deficiencies. CNSC staff will continue to monitor these activities through quarterly inspections.

1B.4.9 Environmental protection

Pickering B performance in environmental protection is rated "satisfactory". This is attributed to the continuation of the measures OPG has taken to reduce fish mortality at both Pickering A and B. See section 2.4.3, "Updates on Significant Regulatory Issues," for details.

The reported dose to the public from Pickering A and B (combined) in 2010 was 1.0 μSv, which is well below the public dose limit of 1,000 μSv.

The monthly liquid release action level was found exceeded in the reactor building service water (RBSW) in June 2010. In response to this exceedance, OPG has increased sampling frequency from weekly to daily on the RBSW effluent. In addition, OPG will hire an external consultant in 2011 to review the results of the investigation into the cause of the RBSW effluent exceedance. The RBSW beta/gamma activity has returned to normal levels and has remained normal to date.

No significant issues were identified regarding groundwater monitoring program in 2010, except OPG is expected to continue to maintain the groundwater site-wide monitoring program.

1B.4.10 Emergency management and fire protection

Emergency management and fire protection at Pickering B was rated "satisfactory" in 2010.

As required by the provincial nuclear emergency plan, OPG is required to install five additional sirens to provide an effective public alert system. Installation of these five sirens will be completed in May 2011. CNSC staff will continue to monitor progress on the installation and testing of the sirens.

CNSC staff's review of inspection findings, surveillance monitoring and S-99 reportable events for 2010 did not identify any significant issues relating to emergency management and fire protection. The performance indicators used to evaluate implementation of the emergency management response plan remained steady or, in some cases, improved throughout 2010.

1B.4.11 Waste management

Waste management at Pickering B was rated "satisfactory" in 2010.

No significant issues were raised as a result of non-radioactive hazardous waste management inspection carried out in 2010.

CNSC staff expect OPG to continue operating in accordance with their nuclear waste management program as described in its document W-PROG-WM-0001, *Nuclear Waste*

Management Program. This program document is listed in the nuclear management system document; therefore, as required by the operating licence, any changes to the program document listed in the nuclear management system document, the licensee shall give written notification to the Commission. The most recent nuclear waste management program document was issued in late 2009.

As per the operating licence requirement, the licensee is to submit a preliminary decommissioning plan (PDP) to the CNSC. The PDP is to be revised periodically at a minimum every five years or as requested by the CNSC. The most recent PDP was issued in 2007 and the next update is planned for submission by June 2012.

1B.4.12 Security

The performance rating for this SCA is presented to the Commission in a separate Commission Member Document (CMD 11-M46.A).

1B.4.13 Safeguards

The safeguards SCA at Pickering B met applicable CNSC requirements and performance objectives in 2010, and received a "satisfactory" rating. There has been a minor change in the station's performance but this did not result in a change in the SCA rating in comparison to last year's performance. OPG has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons*.

Details of the IAEA verification conducted at Pickering A and B can be found in section 1B.3.13.

1B.4.14 Packaging and transport

Packaging and transport at Pickering B was rated "satisfactory" in 2010.

No significant issues were identified regarding packaging and transport in 2010. CNSC staff expect that the licensee will continue to operate in accordance with their radioactive material transport program as described in its OPG document W-PROG-WM-0002, *Radioactive Material Transportation*. This program describes controls that ensure safe, compliant, and efficient radioactive materials transportation. It also includes verification that the transportation emergency response plan is appropriately established.

The radioactive material transportation program document is listed in the nuclear management system document; therefore, as required by the operating licence, any changes to the program document listed in the *Nuclear Management System* document, the licensee shall give written notification to the Commission.

1B.5 Gentilly-2

Table 12 shows the 2010 performance ratings. All SCAs received a "satisfactory" performance rating.

During 2010, there were no serious process failures at Gentilly-2. Worker dose, dose to the public and radioactivity from releases to the environment were below regulatory limits.

Hydro-Québec reported events as per S-99 requirements and conducted appropriate follow-up, including, when necessary, root cause analyses and corrective actions. Based on observations and the assessments of the SCAs, CNSC staff conclude that Gentilly-2 was operated safely and in accordance with its operating licence in 2010.

Hydro-Québec also complied with licence conditions pursuant to Canada's international safeguards obligations in 2010.

Table 12: Performance Ratings for Gentilly-2 for 2010

Safety and Control Area	Rating	Industry Average
Management system	SA	SA
Human performance management	SA	SA
Operating performance	SA	SA
Safety analysis	SA	SA
Physical design	SA	SA
Fitness for service	SA	SA
Radiation protection	SA	SA
Conventional heath and safety	SA	SA
Environmental protection	SA	SA
Emergency management and fire protection	SA	SA
Integrated plant rating	SA	SA
Waste management*	SA	SA
Security*	Prescribed	Prescribed
Safeguards*	SA	SA
Packaging and transport*	SA	SA

* Waste management, security, safeguards, and packaging and transport were excluded from the integrated plant ratings.

1B.5.1 Management system

Gentilly-2's management system SCA was rated "satisfactory" in 2010.

The results of the inspections performed by the CNSC at Gentilly-2 over the last four years revealed that, globally, Hydro-Québec's quality assurance program met the requirements of the CSA N286 series of QA standards (N286.0 through N286.6). However, several issues raised during these inspections had remained open until recently because of delays in implementing the appropriate corrective actions.

In mid-2010, when it was expected that the assessment of the overall implementation of the quality assurance program would have led again to a "below expectations" rating, CNSC staff requested that Hydro-Québec take measures to improve its performance of this program. In August 2010, CNSC staff also requested an explanation from Hydro-Québec on its apparent inability to improve the performance of this program. Hydro-Québec has submitted a corrective action plan covering this SCA and has been implementing it in 2010.

Hydro-Québec was also instructed to correct specific weaknesses raised in the CNSC quality assurance inspection reports. This issue relates to the inspection of the self-evaluation process and to maintenance, as well as internal audits and OPEX feedback. CNSC staff conclude that the licensee has demonstrated that it is capable of eliminating weaknesses and to implement solutions to identified issues.

1B.5.2 Human performance management

Gentilly-2's human performance management SCA was rated "satisfactory" in 2010.

The results of a document review performed at the beginning of 2010 and covering three emergency operating procedures indicated the licensee did not fully comply with the relevant guide for drafting such procedures. Hydro-Québec addressed CNSC staff's action notices and committed to a major revision of the guide for drafting procedures. CNSC staff are satisfied with the actions taken and closed this issue.

Personnel training

In September 2010, Hydro-Québec submitted to the CNSC a revised action plan and timeline for the implementation of the systematic approach to training (SAT). CNSC staff have reviewed the revised action plan, and is monitoring Hydro-Québec's progress against it.

Examination and certification

In 2010, five out of six candidates successfully completed the initial certification examinations at Gentilly-2. None of the Gentilly-2 certified staff had to take the requalification examination in 2010.

1B.5.3 Operating performance

Gentilly-2's operating performance SCA was rated "satisfactory" in 2010.

Periodic and in-service inspection programs
A periodic inspection program and an in-service inspection program have been put into operation at Gentilly-2. The purpose of these programs is to conduct periodic inspections in accordance with the codes and standards currently in effect in order to provide assurance of plant systems and equipment integrity.

In July 2010, Hydro-Québec submitted a new revision of the document DR-22, *Periodic Inspection Program*.

Continuous assurance of safety at the plant
A CNSC staff inspection of the emergency power supply led to the requirement for Hydro-Québec to submit a plan to ensure its durability. In December 2010, Hydro-Québec submitted an improvement plan, which CNSC staff found acceptable. CNSC staff will close this issue once the actions linked to the inspection have been completed. The target completion date for these actions is June 30, 2011 and this will be followed by a CNSC field inspection prior to the closure of this issue.

Corrective action and operational experience feedback programs
In 2008, CNSC staff completed a document review of the corrective actions related to the events reported in accordance with Regulatory Document S-99. Important delays in the implementation of corrective actions and the completion of event analyses were noticed. Based on this observation, CNSC staff requested Hydro-Québec to provide additional information on the planned actions to prevent delays in publishing the results of event analyses. Hydro-Québec submitted an action plan that was approved by CNSC staff. This action item was closed in September 2010.

Operating policies and principles
Hydro-Québec staff operate the plant in accordance with the requirements of the OP&Ps. There were only minor deviations from the OP&Ps in 2010. In addition, for maintenance purposes and in order to make repairs to the plant, Hydro-Québec has correctly documented and submitted to the CNSC requests for these minor deviations from the OP&Ps.

CNSC staff conclude that the OP&Ps related program and its implementation meet the regulatory requirements.

Development of the safe operating envelope
For more than a year, the nuclear power industry and the CNSC have been involved in developing requirements regarding the SOE of NPPs. The intent of the SOE is to establish a set of limits and conditions that will ensure that the operation of Gentilly-2 is conducted in accordance with the safety analyses. This will allow replacing the operating limits found in the OP&Ps.

In 2010, there was one forced outage, no trips, one stepback and no setbacks at Gentilly-2. There were no serious process failures.

1B.5.4 Safety analysis

Gentilly-2's safety analysis was rated "satisfactory" in 2010.

Regulatory Document RD-310, *Safety Analysis for Nuclear Power Plants*
Hydro-Québec submitted in December 2010 an update of their plan to implement Regulatory Document RD-310. CNSC staff are reviewing Hydro-Québec's submission together with those from other licensees. At this stage, CNSC staff are satisfied with the progress made regarding this issue and concludes that it had no impact on the plant safety.

Impact of plant aging on safety analyses
As requested by CNSC staff, Hydro-Québec submitted during 2010 updates of the plant aging impact analyses. CNSC staff assessed these analyses and concluded that they adequately cover the period of operation up to the planned outage in 2011.

Probabilistic safety assessment
CNSC staff completed a review of the Level 1 probabilistic safety assessment (PSA) methodology and found that it was acceptable.

Hydro-Québec submitted its Level 1 PSA in December 2010 and CNSC staff expect to complete the review of this document by the spring of 2012. A Level 1 PSA is an analytical tool used to determine and quantify hypothetical event sequences that could lead to a loss of the core structural integrity and fuel failure. As it is hypothetical, this assessment has no impact on plant safety.

1B.5.5 Physical design

Gentilly-2's physical design SCA was rated "satisfactory" in 2010.

Pressure boundaries
The Gentilly-2 NPP pressure boundary design program meets the requirements of standards N285.0 (1995) and B51 (2003). Hydro-Québec indicated that it intended to meet the requirements of N285.0 (2006) when submitting its new pressure-retaining system and component program. Following discussions between CNSC and Hydro-Québec, the licensee indicated that it plans to obtain approval of its revised quality control program for pressure retaining systems and components by December 31, 2011 and to complete its implementation by June 2012. CNSC staff find this timetable acceptable and to have no impact on plant safety.

1B.5.6 Fitness for service

Gentilly-2's fitness for service SCA was rated "satisfactory" in 2010. CNSC staff do not have major concerns with the licensee's performance under this SCA and will continue to follow-up on the issues that are still open but having little impact on plant safety.

Maintenance

CNSC staff found good compliance with the Gentilly-2 NPP guidelines on work approval and concluded that the maintenance program meets the regulatory requirements. CNSC staff will continue to monitor procedures implementation as well as the maintenance backlog.

Outage management

CNSC staff performed an inspection of operational practice assessment and observed good practices related to the management of the GSS as well as compliance with conventional health and safety requirements (non radiological). Non-compliances related to communications were noted during the planned outage in 2009. Hydro-Québec submitted action plans at the beginning of 2010. CNSC staff reviewed these plans and closed the issue at the end of 2010. In comparison to previous years, an improvement was detected during 2010 with regards to communications, incident management, radiation protection practices, procedural compliance and combustible load storage practices. No major deficiencies were identified during the 2010 planned shutdown inspections.

CNSC staff conclude that the shutdown management program and its implementation meet the regulatory requirements.

Structural integrity

Feeders

Hydro-Québec conducted a feeder inspection campaign during the shutdown in the spring of 2010. 200 feeders on the south side and another 221 feeders on the north side were inspected and no flaws were identified. CNSC staff are satisfied with the results of this inspection campaign and of those of several preceding campaigns and believe that the feeders are fit for service until April 2012. To continue operation beyond that date, Hydro-Québec will have to extract feeder C17, perform additional inspections, or obtain concurrence from the CNSC on new measures to deal with the results of the last inspection.

Steam generator

The last planned visual inspection of the secondary side of the steam generators was performed in the spring of 2005 and the results were satisfactory. CNSC staff agreed to extend by 18 months the five-year interval specified by standard N285.4 for the visual inspection of the secondary side. With this dispensation, Hydro-Québec has until December 2011 to carry out a visual inspection of the secondary side or to submit a request to get a new dispensation.

Fuel channels

Hydro-Québec has recently submitted its operation plan that will take into account all the aging mechanisms and the fuel channel operating limits in the forthcoming proposals, as per the standards currently in place.

CSA standard N287.7, *In-Service Examination and Testing Requirements for Concrete Containment Structures*

To ensure that the plant containment structure continues to be capable to perform its functions, the licensee must comply with CSA standard N287.7 that applies to periodic inspections of the containment structure and all its components such as the pre-stressing system, the walls, beams and columns, the vault, the caulking, the interior coating and the foundation.

As part of the station relicensing process, CNSC staff have initiated discussions with Hydro-Québec on establishing a periodic inspection program that meets N287.7 (2008) requirements and on the preparation and implementation of a management plan to ensure the durability of the concrete containment structures.

It should be noted that N287.7 does not appear in the current licence, but will be included in the next operating licence for Gentilly-2.

To promote the application of CSA standard N287.7, an inspection was carried out at the end of March 2010 which identified several improvement opportunities. CNSC staff noted that Hydro-Québec does not inspect all components of the containment structure prescribed by the standard.

CSA standard N285.4, *Periodic Inspection of CANDU Nuclear Power Plant Components*

To ensure that the NPP containment structures can fulfill their functions, Hydro-Québec must conduct, in accordance with CSA standard N285.4, regular periodic inspections of the major plant components such as safety systems components and primary heat transport system components (feeders, fuel channels, steam generators, etc.).

Hydro-Québec used N285.4 to develop and implement its periodic inspection program of the major plant components. This program allowed Hydro-Québec to make the necessary corrections to maintain these components in a good state and to adequately demonstrate their continued fitness for service.

In the past, Hydro-Québec experienced difficulties in meeting some deadlines and requirements of N285.4.

In most cases, Hydro-Québec had attributed these difficulties to being unaware of the regulatory nature of N285.4, to its misinterpretation of the standard and to incomplete allocation of the roles and responsibilities related to this standard. Gentilly-2 document DR-22, *Periodic Inspection Program*, was to be revised to meet the requirements of the latest revision of CSA standard N285.4 and to better define the organizational structure

and roles and responsibilities related to this standard. In July 2010, Hydro-Québec submitted to the CNSC a version of an update to the program in DR-22.

Reliability

Reliability of systems important to safety
The reliability of systems important to safety is described annually in the reliability report submitted in accordance with S-99 requirements. CNSC staff conclude from assessing the Gentilly-2 reliability report that the systems important to safety reliability met regulatory regulations.

The Gentilly-2 reliability program is properly organized and appropriately maintained. CNSC staff found that Gentilly-2's reliability program meets the regulatory requirements and is therefore satisfactory.

Environmental qualification of equipment
In 2010, Gentilly-2 submitted a follow-up environmental qualification (EQ) report in response to deficiencies that had no safety impact on the station's operation. The Gentilly-2 EQ program implementation is progressing slowly as many pieces of equipment require environmental qualification. The integrity of the program is assured at Gentilly-2 and its performance was found to be satisfactory.

1B.5.7 Radiation protection

Gentilly-2's radiation protection SCA was rated "satisfactory" in 2010.

Radiation protection framework
In 2010, Hydro-Québec updated and completed all radiation protection program implementation documents and submitted to the CNSC for approval new revisions of two framework documents, DR-46, *Radiation Protection Program* and PI-22-01-02, *Radiation Protection Action Levels and Administrative Limits*. CNSC staff have recently approved document PI-22-01-02 and sent its comments on document DR-46 in March 2011.

Inspections
In 2008 and 2009, CNSC staff carried out radiation program compliance inspections that addressed contamination control, radiation protection instrumentation and equipment as well as the respiratory protection program. During these inspections, CNSC staff identified issues needing improvement and initiated enforcement measures to draw attention to these deficiencies. In response, Hydro-Québec undertook appropriate action plans and corrective actions. CNSC staff will continue to follow up on these corrective actions until the enforcement measures are closed.

In addition, CNSC staff conducted an inspection in December 2009 that covered various aspects of the program such as:

- radiation protection organization and administration
- staff qualification and performance in radiation protection
- radiation protection staff qualification and performance
- radiation exposure and dose control
- solid radioactive waste and transportation of radioactive material
- radioactive contamination control

This inspection also touched on the radiation protection program for the Gentilly-2 refurbishment project. CNSC staff identified strengths regarding the involvement of management and staff in radiation protection practices and the radiation protection program organization and administration. However the subject areas of documentation, processes and training need improvements. Enforcement measures and recommendations have been issued for the latter.

Hydro-Québec and the CNSC have agreed on a timeline for the implementation of the actions needed to close the issues still open.

In the light of the inspection results, CNSC staff conclude that the Gentilly-2 NPP radiation protection program meets the regulatory requirements.

Radiation exposure control

In 2010, there were no radiation exposures of workers at the Gentilly-2 NPP that exceeded regulatory limits or administrative limits set by Hydro-Québec, that is, cumulative individual annual dose limit of 20 mSv.

The Gentilly-2 radiation program maintains the collective doses as low as reasonably achievable (ALARA).

Under the ALARA principle various strategies are in place to diminish the contamination risk and to minimize worker doses. The ALARA program framework is defined and ALARA initiatives are being implemented to lower the risk of contamination. Some of the initiatives include: ensuring the cleanliness of the rooms in the accessible areas of the reactor building, reducing tritium exposure through engineering means, installing protective barriers where necessary, and improving human performance in order to prevent unplanned exposures.

Information on the radiological risks is used when planning and performing radiation work, when establishing the boundaries of the radiological work areas and when establishing the areas where and conditions when a dosimeter is to be worn.

The 2010 dose information for Gentilly-2 is provided in Appendix F.

Radiation protection action plan

CNSC staff continued in 2010 to follow up on the implementation of the radiation protection action plan established by Hydro-Québec in 2006. It includes actions aimed at improving the communication of expectations, the follow-up in radiation protection and the supervision of radiation protection activities, the reinforcement of the observations and the revision of radiation protection procedures and at putting in place a team dedicated to improving work practices. CNSC staff observed that the measures taken so far to improve the radiation protection program allow effective implementation of good radiological safety practices.

1B.5.8 Conventional health and safety

Gentilly-2's conventional health and safety SCA was rated "satisfactory" in 2010.

CNSC staff observed during an inspection of the respiratory protection program in 2009 that Gentilly-2 did not meet all the requirements and that many program activities were not yet documented. Hydro-Québec has taken actions to eliminate these non-compliances. Respiratory protection program documentation has been submitted and has been assessed by CNSC staff.

Subsequently, during field inspections conducted in 2010, CNSC staff found that compliance regarding the use of individual protective equipment was adequate.

Accident severity rate

For 2010, the value for the accident severity rate (see section 1A.8 for definition) was 8.44, which is commensurate with the NPP average in Canada. Even though the eight accidents with lost time injuries or requiring temporary assignments during this period were not severe, the situation must be monitored.

Overall though, CNSC staff found an improvement in the performance of the occupational health and safety program that can be attributed to, among other things, better program management.

1B.5.9 Environmental protection

Gentilly-2's environmental protection SCA was rated "satisfactory" in 2010.

Environmental management system

CNSC staff conducted an audit of the environmental management system in March 2006. This audit identified non-compliances. CNSC staff concluded that the risk associated with these non-compliances was minor. Hydro-Québec completed the required actions and submitted in December 2010 the information in support of a request for closure of this issue. CNSC staff assessed the information and closed this issue in February 2011.

Environment and effluents radiological monitoring program
The performance of the radiological effluent monitoring program is assessed by checking the public dose and the level of compliance of the releases of radioactive material into the environment via gaseous and liquid effluents. In 2010, the releases remained below the regulatory limits and action levels.

Derived release limits
While awaiting the submission of a new derived release limit (DRL) document complying with CSA standard N288.1-08, a common agreement was reached to use temporary DRLs. Hydro-Québec submitted the temporary DRLs in October 2010 and CNSC staff found them acceptable. In December 2010, Hydro-Québec submitted new DRL values based on CSA standard N288.1-08 and the method used to derive these values in January 2011. CNSC staff approved the new DRLs and closed the action item in 2011. It should be noted that releases during operation are well below the limits, the current and interim arrangements are thus safe for the population and the environment.

Accidental releases
In accordance with Regulatory Standard S-99, *Reporting Requirements for Operating Nuclear Power Plants*, licensees report unplanned releases to the environment of nuclear or hazardous substances. Some non-radioactive spills (oil, antifreeze) occurred in 2010. These spills were related to plant operation. In each case, the licensee responded adequately and there was no effect on the environment to be reported.

CNSC staff has found that the environmental protection program at Gentilly-2 is satisfactory. The radionuclide releases through both airborne and waterborne pathways remained below the derived release limits and the public dose of 1.0 μSv is well below the dose limit of 1,000 μSv.

1B.5.10 Emergency management and fire protection

Gentilly-2's emergency management and fire protection SCA was rated "satisfactory" in 2010.

Emergency management
As part of its emergency response plan management program, Hydro-Québec has taken the necessary measures to address the issues raised during CNSC inspections. Consequently, the preparedness for radiological emergencies and the efficiency of such responses remain fully satisfactory at Gentilly-2.

Fire protection
Compliance inspections, event reviews and document reviews conducted during 2010 identified weaknesses in the fire protection program. Hydro-Québec committed to perform an in-depth analysis to identify and eliminate the shortcomings of its program in relation to the regulatory requirements. CNSC staff observed that Hydro-Québec has introduced compensatory and preventive measures and submitted a timeline for the work to be completed by the end of 2012.

CNSC staff concluded that the Gentilly-2 fire protection program is no longer up-to-date and must be revised to meet the requirements of standard N293-07 which was recommended for inclusion in the next operating licence. However, CNSC staff found that the deficiencies in the fire protection program do not constitute an unreasonable risk at the present time to the workers, the public, station safety and the environment.

Industrial fire brigade

The assessment of the industrial fire brigade performance conducted by CNSC staff in 2009 identified deficiencies with its response and the observations made indicated that the brigade's performance needed to be improved. In an action plan submitted in March 2010, Hydro-Québec committed to complete the required corrective actions. CNSC staff will continue to follow-up on this issue until the necessary actions are completed.

1B.5.11 Waste management

Gentilly-2's waste management SCA was rated "satisfactory" in 2010.

In 2010, CNSC staff conducted two compliance inspections of the waste facility. Even though improvements must be made to the management of the radiation instrumentation, they do not compromise individual health and safety because alternative procedures are still in place. Hydro-Québec's staff at Gentilly-2 was not exposed to radiation in excess of regulatory dose limits during the activities related to this SCA.

As per the conditions of its waste management facility licence, Hydro-Québec submitted construction notices and commissioning reports to the CNSC for review and approval. The licensee also forwards an annual report on the construction activities for review by CNSC staff.

CNSC staff conducted an inspection of the waste facility which led to a directive being issued regarding access to the radiological area of the radioactive waste storage area. It was concluded that Hydro-Québec took acceptable measures to correct the situation.

1B.5.12 Security

The performance rating for this SCA is presented to the Commission in a separate Commission Member Document (CMD 11-M46.A).

1B.5.13 Safeguards

Gentilly-2's safeguards SCA was rated "satisfactory" in 2010.

The safeguards SCA at Gentilly-2 met applicable CNSC requirements and performance objectives in 2010. There has been a minor change in the station's performance but this did not result in a change in the SCA rating in comparison to last year's performance. Hydro-Québec has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons*.

The IAEA conducted a PIV at Gentilly-2 during July 6 to 9, 2010, to verify that no diversion of nuclear material had taken place, to detect any tampering with the IAEA's containment/surveillance system, and to confirm the declarations provided by the state authorities and facility operators. The inspection was attended by CNSC staff, who reviewed the facility's support for IAEA inspectors including: escorts and equipment; the provision of accountancy information and supporting documents; the facility compliance with safeguards licence conditions relevant to the inspection activity; and the IAEA's adherence to its rights and obligations relevant to the inspection. No significant compliance issues were identified.

CNSC staff monitored the installation of IAEA equipment needed for the implementation of integrated safeguards for spent fuel transfers to dry storage. Although delays were encountered, a majority of the spent fuel transfer campaign was completed under the new safeguards approach. CNSC will continue to monitor improvements to the implementation of safeguards at Gentilly-2 in 2011.

1B.5.14 Packaging and transport

Gentilly-2's packaging and transport SCA was rated "satisfactory" in 2010.

Packaging and transport covers the packaging and transportation of nuclear substances, including packaging and packages design, fabrication, usage, inspection, maintenance and repairs as well as the preparation, shipping, handling, loading, dispatching, storage in transit, reception at final destination and unloading of packages.

CNSC staff assessed the licensee's performance in this area through reviewing shipping procedures and the quarterly reports submitted to enable verification of compliance with the PTNSR.

1B.6 Point Lepreau

In 2010, New Brunswick Power (NB Power) continued refurbishment activities at Point Lepreau. As such, the station was not operational, and the performance of certain specific areas could not be rated. In view of refurbishment activities coming to an end and restart planned for 2012, some areas not evaluated or rated in 2009 as a result of refurbishment activities have been assessed for 2010.

During 2010, CNSC staff continued to review, inspect and monitor NB Power's activities related to the refurbishment, as well as conducting ongoing reviews of licensee performance in other areas, such as, but not limited to, radiation protection, environmental releases, safety, security and international obligations.

Table 13 presents the safety performance ratings for Point Lepreau for 2010. Of the SCA that were rated, all received "satisfactory" ratings, except for "emergency management and fire protection," which received a "below expectations". The 2010 integrated plant rating for Point Lepreau was "satisfactory"; this is the same integrated plant rating as received by this licensee in 2009.

In 2010, no worker or member of the public received a dose in excess of the regulatory dose limits, and all environmental emissions were below regulatory limits and station action levels.

Table 13: Performance Ratings for Point Lepreau for 2010

Safety and Control Area	Rating	Industry Average
Management system	SA	SA
Human performance management	SA	SA
Operating performance	SA	SA
Safety analysis	SA	SA
Physical design	SA	SA
Fitness for service	SA	SA
Radiation protection	SA	SA
Conventional heath and safety	SA	SA
Environmental protection	SA	SA
Emergency management and fire protection	BE	SA
Integrated plant rating	SA	SA
Waste management*	SA	SA
Security*	Prescribed	Prescribed
Safeguards*	SA	SA
Packaging and transport*	SA	SA

* Waste management, security, safeguards, and packaging and transport were excluded from the integrated plant ratings.

1B.6.1 Management system

Point Lepreau's performance in this SCA was rated "satisfactory" in 2010.

The reporting for the management system SCA reflects those quality assurance activities related to refurbishment, since Point Lepreau continues to be in a state of shutdown. CNSC monitoring of refurbishment activities did not detect any management system deficiencies for the restart of Point Lepreau.

NB Power has established and implemented a quality assurance program per the requirements of the CSA N286 Series of QA standards for the operation of the plant. This program has also been implemented for the refurbishment activities. The Point Lepreau operating licence was recently renewed for one year, with an expiry date of June 30, 2012. The renewal of the operating licence in 2012 will require the licensee to implement the newest version of CSA standard N286-05, *Management System Requirements for Nuclear Power Plants*.

In 2010, NB Power made organizational changes in preparation for transitioning from refurbishment to operational mode. CNSC review of these organizational changes identified no deficiencies.

In the past three years, the normal oversight and review activities of operational station performance were diminished during ongoing refurbishment activities. The corrective action program and the self-assessment program were challenged due to the demands of the refurbishment project. Both programs are now being fully re-established by NB Power, in preparation for the restart.

1B.6.2 Human performance management

Point Lepreau's performance in human performance management was "satisfactory" in 2010.

Licensees limit the number of hours that can be worked by staff, in order to reduce the risk of impaired performance due to fatigue. CNSC staff conducted an inspection in 2006 that identified deficiencies in NB Power's hours of work process. NB Power has taken actions to ensure that hours of work procedural non-compliances are being documented and minimized. There have been a number of hours of work exemptions being applied in accordance with the hours of work procedure. CNSC staff will continue to have oversight on NB Power's progress to improve hours of work throughout the 2011–12 fiscal year.

The administration of certification examinations at Point Lepreau is satisfactory. The certification examinations met the minimum requirements for the purpose of initial certification of workers.

Training is expected to follow a systematic approach to training (SAT) methodology. CNSC staff have observed in past drills and desktop reviews that although NB Power has

a SAT-based system in place and adequately implemented it for operations, it is not implemented in other areas effectively. Further deficiencies identified during a CNSC inspection of fire brigade and emergency response drills in 2010 indicated that in the area of personnel training, Point Lepreau is performing below expectations.

In 2010, two out of three candidates successfully completed the initial certification examinations at Point Lepreau. Furthermore, eight out of ten candidates successfully completed requalification examinations in 2010.

1B.6.3 Operating performance

Point Lepreau's performance in this SCA was rated "satisfactory" in 2010.

The plant remained shut down as the refurbishment outage continued. The shutdown continued throughout the year to permit retubing of the reactor as well as the completion of other system upgrades. External radiation fields were substantially lower with no fuel in the core and the reactor components removed. With both heavy water systems drained to storage tanks, the airborne tritium fields were also low except in the immediate vicinity where the heavy water is stored. Contamination levels have also been reduced significantly.

CNSC site staff activities during the year included surveillance and monitoring, walk-down inspections, and verification of installation and commissioning of modifications and upgrades.

1B.6.4 Safety analysis

Point Lepreau's performance in safety analysis was "satisfactory" in 2010.

NB Power made adequate progress in safety analysis of ongoing refurbishment activities and in a number of on-going safety analysis programs or topics: S-294 compliance in the area of probabilistic safety assessment (PSA), safety analysis improvement (SAI) program, safe operating envelope and the impact of plant aging on safety analysis.

The safety report has been updated and accepted by CNSC staff. The new version will be included in a licence amendment in 2011.

1B.6.5 Physical design

Point Lepreau's performance in this SCA was rated "satisfactory" in 2010.
Many design improvements were implemented as part of the Point Lepreau refurbishment (PLR) project to extend the operating life of the Point Lepreau NPP by 25 to 30 years. The major activity to be performed during the outage, referred to as retube, is the replacement of all 380 fuel channel assemblies, calandria tubes, and the entire length of connecting inlet and outlet feeder piping from the end fittings to the headers. In

addition, the PLR project included a number of repairs, replacements, inspections, and upgrades, as well as other routine operations and maintenance activities. Safety improvements included the addition of a filtering system to the main control room to protect its air supply in the event of an accidental release of radioactive material following a severe accident, as well as improvements to the trip coverage on shutdown systems 1 and 2 for moderator related events involving leak, loss of circulation and loss of cooling.

CNSC staff performed a number of reviews associated with the EQ of equipment, resulting in recommendations to NB Power staff and requests for additional documentation for review. During an inspection, a number of actions were raised which NB Power has either addressed or presented a plan for resolution.

The overall configuration management (CM) baseline program has been implemented, although there are some weaknesses in CM sustaining activities such as design documents not reflecting the actual physical plant. The CM program requires continued support in other ongoing processes such as engineering change control, performance monitoring, maintenance, aging management and corrective actions. However, no significant issues have been identified.

Reviews were conducted of human factors (HF) design activities relating to the solid radioactive waste management facility and the retube tooling HF validation. Follow up activities were also carried out in relation to an inspection for incorporation of HF activities into design. CNSC staff have acknowledged progress, but there are still some specific areas for improvement in HF in design, such as verification and validation, and contractor oversight of HF in design work. Further follow up activities will be carried out in 2011.

1B.6.6 Fitness for service

Point Lepreau's performance in fitness for service was "satisfactory" in 2010.

Point Lepreau has been under refurbishment since 2008. Point Lepreau is the first NPP in Canada to update its PIP documents to N285.4-09. Following an initial review of the PIP documents by the CNSC, an action was raised for NB Power to address deficiencies prior to final acceptance. It is expected that the revised program will be implemented for restart following the refurbishment outage.

Point Lepreau has an acceptable program for CSA N285.5-90, and has satisfactorily performed and reported periodic inspections of containment components according to CSA N285.5 and S-99 respectively. NB Power will be transitioning to the next version of this CSA standard as part of the next licence renewal.

In late 2009, NB Power staff submitted the technical assessment report for the ring beam delamination in the Point Lepreau reactor building as part of the refurbishment project repairs/improvements. As a result of the CNSC's assessment of the ring beam

delamination, an action was raised by the CNSC to track the ring beam issues and NB Power was requested to submit a PIP meeting the requirements of CSA N287.7-08, as well as an aging management program (AMP) for the reactor building

In March 2010, NB Power submitted the AMP to CNSC for review, which included the PIP for the reactor building. Subsequently, preliminary assessment by CNSC staff of the AMP/PIP document was provided to NB Power. NB Power is expected to finalize the AMP/PIP document for the reactor building and submit it to CNSC for review and acceptance.

In October 2010, CNSC staff performed an inspection of the on-going inspection and repair work for the ring beam and the reactor building at Point Lepreau. Six actions were identified from the inspection and the findings were provided to NB Power for resolution as part of the ongoing refurbishment work.

1B.6.7 Radiation protection

Point Lepreau's performance in radiation protection remained "satisfactory" in 2010.

Based on the assessment of its findings in this area, CNSC staff are satisfied that NB Power provided adequate protection of the health and safety of persons inside their facilities with respect to ionizing radiation.

The 2010 dose information for Point Lepreau is provided in Appendix F. There were no radiation exposures at Point Lepreau that exceeded regulatory limits or the station action levels in 2010.

In July 2010, CNSC staff was informed by NB Power that a contaminated tool, sealed and packaged, was inadvertently transferred to an off-site warehouse. Although the contamination was contained at all times the loose contamination within the packaging exceeded a contamination control limit as defined in NB Power's radiation protection (RP) program. NB Power declared and reported this condition to the CNSC as reaching an action level. NB Power took immediate measures to ensure that members of the public were protected. There was no spread of contamination or exposure to a member of the public as a result of this incident. CNSC staff are satisfied that NB Power conducted an appropriate follow-up investigation and implemented suitable corrective actions.

It was noted in the 2009 NPP Report that improvement at Point Lepreau was required in effectively executing whole body counting for ascertaining and recording workers' doses. CNSC staff have closely monitored the effectiveness of the corrective measures that were implemented by NB Power and are satisfied that these deficiencies are resolved.

In 2010, NB Power continued to anticipate alpha hazards and implemented appropriate measures to protect workers. These measures were effectively implemented throughout calendar year 2010.

1B.6.8 Conventional health and safety

Point Lepreau's performance in conventional health and safety was "satisfactory" in 2010.

WorkSafeNB[3] has routinely conducted inspections at the Point Lepreau Generating Station site since the beginning of the refurbishment outage. CNSC inspectors participated in the majority of these inspections in 2010, and routinely attended the weekly contractor safety meetings led by NB Power.

Isolated instances of housekeeping deficiencies surfaced during the year. Subsequent inspections have found that the problems have been resolved and measures put in place to prevent reoccurrences. Workers are wearing personal protective equipment as required.

The accident severity rate (see section 1A.8 for definition) reported for Point Lepreau in 2010 was 38.96, which is considerably higher than the 2009 ASR value of 5.90. A contract employee was injured by a scaffold component while dismantling the scaffold and two workers injured their backs while unlatching a door and placing tools in a bag. Three employees were injured by trips, slips and an ankle sprain while training. Four injuries resulted in restricted work conditions placed on the employees.

1B.6.9 Environmental protection

Environmental protection at Point Lepreau continued to be "satisfactory" in 2010.

The results of the environmental management system were similar to those of last year. Environmental monitoring is continuing on site during the refurbishment with the estimated dose to the public and control of releases kept at low levels. In 2010, the reported dose to the public from Point Lepreau was 0.2 μSv, which is well below the public dose limit of 1,000 μSv. Gaseous and aqueous releases of nuclear substances were considerably below the environmental action levels.

1B.6.10 Emergency management and fire protection

Good progress was made at Point Lepreau in implementing fire protection design and testing in 2010. However, the emergency management and fire protection SCA rating has decreased to "below expectations". Deficiencies noted in emergency management and response outweighed good performance in the implementation of planned fire protection design modifications.

[3]WorkSafeNB oversees the implementation and application of the New Brunswick *Occupational Health and Safety Act*, the *Workers' Compensation Act* of New Brunswick, and the *Workplace Health, Safety and Compensation Commission Act* of New Brunswick.

CNSC staff conducted an inspection of Point Lepreau Generating Station emergency response team (ERT) capability during scheduled fire brigade and emergency response team drills in October 2010, which concluded that NB Power did not meet expectations and as a result, NB Power was requested to:

- improve the conduct, performance and proficiency of the ERT in conducting fire fighting operations
- ensure the training and certification of the ERT and ERT leaders follows a systematic approach to training (see section 1B.6.2)
- implement the requirements to conduct realistic and representative drills and exercises of the hazards and risks at the Point Lepreau NPP

NB Power does, however, meet expectations in Phase I of the design and installation of fire protection upgrades and is working towards resolution of issues in Phase II. The two phases in the NB Power schedule of the fire protection design upgrades are modifications necessary pre-restart of the reactor or during the refurbishment outage (Phase I) and modifications post-restart (Phase II).

The Phase I modifications are to resolve design compliance issues and include upgrades to the fire alarm system, building egress, and fire suppression system. CNSC staff have reviewed and inspected the modifications implemented to date, acknowledged the progress made to date, and expects NB Power to achieve the target dates identified in Phase I of installation of fire protection modifications.

The Phase II modifications relate to deficiencies identified in the fire hazard analysis, fire system testing, and in support of the current challenges with the ERT. The implementation schedule is being tracked under a dedicated CNSC action items that is being reviewed periodically.

NB Power is implementing interim compensatory measures to provide additional assurance for fire protection, and manage residual risk until all planned modifications can be fully installed and commissioned, and all deficiencies with the ERT are resolved. CNSC staff are monitoring the effectiveness of these actions. Satisfactory rating in this SCA is a prerequisite of return to service of the reactor.

1B.6.11 Waste management

The waste management SCA for Point Lepreau was rated "satisfactory" in 2010.

The licence for NB Power includes the solid radioactive waste management facility. This site is not co-located with the site of the power reactor, so waste must be transported for a short distance on a private road. Oversight for waste transfers is maintained by CNSC staff at the Point Lepreau site office and the Wastes and Decommissioning Division in Ottawa.

Point Lepreau's preliminary decommissioning plan meets the requirements of CNSC Regulatory Guide G-219, *Decommissioning Planning for Licensed Activities*. It will require an update at the completion of the refurbishment project.

1B.6.12 Security

The performance rating for this SCA is presented to the Commission in a separate Commission Member Document (CMD 11-M46.A).

1B.6.13 Safeguards

The safeguards SCA at Point Lepreau met applicable CNSC requirements and performance objectives in 2010, and received a "satisfactory" rating.

There has been a minor change in the station's performance but this did not result in a change in the SCA rating in comparison to last year's performance. NB Power has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons*.

The IAEA did not select Point Lepreau for a PIV in 2010. In its absence, the CNSC conducted a physical inventory taking evaluation, to provide assurance to the IAEA that the facility was properly prepared for a PIV, had it been selected. No significant compliance issues were identified.

In September, IAEA inspectors undertook to perform a short-notice random inspection at Point Lepreau but were unable to access most of the new fuel due to scaffolding in the corridor to the new fuel room, which blocked entry of the forklift into the room. Neither the CNSC nor the IAEA were informed in advance of the difficulties in accessing new fuel due to the presence of scaffolding. A follow-up visit by the IAEA was required to complete the inspection. Point Lepreau staff have been reminded that any situation or incident that could interfere with safeguards implementation should be immediately brought to the attention of the CNSC and the IAEA. While the absence of notification did not significantly impact the facility's rating in 2010, CNSC staff will closely monitor compliance in 2011.

1B.6.14 Packaging and transport

The packaging and transport program at Point Lepreau met the requirements and/or expectations of CNSC staff. Therefore, Point Lepreau's performance in packaging and transport was "satisfactory" in 2010.

This SCA includes the oversight of packaging and transportation of nuclear substances. All steps in the process are covered including the packing of the substances, shipping, handling, loading, dispatching, storage in transit, reception at final destination and

unloading of packages. The design of packages, their fabrication, usage, inspection, maintenance and repairs are all defined by standards.

CNSC on-site staff assessed the licensee's performance in this area through reviewing shipping procedures and quarterly reports submitted to enable verification of compliance with the PTNSR.

Part 2 – Regulatory developments and issues

Part 2 of this report provides detailed information on various regulatory developments and issues including:

- licensing
  - licence amendments
  - revisions to the LCH
  - progress made on licensing commitments
- updates on major projects and initiatives
- updates on significant regulatory issues

In recognition of the complexity and on-going nature of many regulatory issues, information in this section is kept as current as the NPP Report preparation deadlines will allow. Accordingly, the reporting period for Part 2 is January 2010 to April 2011.

There were two generic regulatory directives issued by CNSC during the reporting period and these are given below and details, where applicable, will be given in the individual station Part 2 sections.

Alpha monitoring program
Based on preliminary information received in 2010 by the CNSC, it appears that there was the potential for workers conducting fuel handling and maintenance activities, and possibly other workers, to be exposed to alpha radiation. In June 2010, pursuant to subsection 12(2) of the *General Nuclear Safety and Control Regulations*, the CNSC requested all NPP licensees to:

- perform a risk identification and characterization survey with respect to the presence of alpha hazards in their NPPs
- implement work controls to mitigate potential alpha exposures for fuel handling workers in their NPPs
- enhance radiation protection program requirements related to alpha monitoring and control, as deemed necessary (programmatic requirements must take current industry best practices and OPEX into account)

In July 2010, CNSC staff concluded that the proposed plans from the NPP licensees for the completion of the requested actions are acceptable. CNSC staff are satisfied that licensees will complete the required risk identification and characterization surveys, and gap analyses of current work controls in a timely manner.

Lessons learned from the Japanese earthquake and tsunami
In response to the events in Japan, CNSC staff sent a written request on March 17, 2011 under section 12(2) of the GNSCR to licensees of major nuclear facilities in Canada to complete specific actions at their facilities, including:

- review initial lessons learned from the earthquake in Japan and re-examine the safety cases of NPPs, in particular the underlying defence-in-depth concept with focus on:
  - external hazards such as seismic, flooding, fire and extreme weather events
  - measures for prevention and mitigation of severe accidents
  - emergency preparedness
- report on implementation plans for short-term and long-term measures to address any significant gaps

All NPP licensees provided the requisite initial response, identifying their proposed plan and schedule to meet the CNSC's request. The licensees have concluded that the overall safety case remains strong. Furthermore, the CNSC has performed a series of walk-downs at each station to confirm this.

Notwithstanding these efforts, the licensees are working diligently to identify potential improvements. The licensees have also begun to accelerate programs that will provide early benefits, in particular in the areas of severe accident management and emergency preparedness.

CNSC task force

The CNSC convened a task force to evaluate and document operational, technical and regulatory implications of the Japan 2011 nuclear event on Canadian NPPs. Specifically, it will review provisions taken by licensees in the design basis (initiating events) and beyond the design basis (available design margins, diversity, redundancy, barrier integrity, physical separation) for NPPs. A draft report is expected by July 27, 2011 with a final report planned for October 7, 2011.

Licensees responses

Meanwhile, the status of each of the licensee responses to the CNSC's request is described below.

Ontario Power Generation

OPG provided an initial response on March 28, 2011, committing to provide further results by April 29, 2011.

On April 28, 2011, OPG confirmed that it had completed a preliminary re-examination of the safety cases and that the risk related to station operation continues to be acceptably low. OPG identified areas for further study and follow-up and will provide an update by May 28, 2011. These areas include station verification activities, severe accident management guidelines, hydrogen mitigation, external events, and irradiated fuel bay issues.

Bruce Power

Bruce Power provided an initial response on March 22, 2011, committing to review the adequacy of measures implemented to deal with beyond design basis events and

implement actions needed to close any identified gaps. Bruce Power will submit a report by July 28, 2011.

Hydro-Québec

Hydro-Québec provided an initial response on March 28, 2011, committing to evaluate external events and its ability to alleviate conditions resulting from beyond design basis events. Hydro-Québec will propose remediation, where necessary, in a final report at the end of July 2011.

New Brunswick Power

NB Power provided an initial response on March 28, 2011, noting that extensive reviews and implementation of a number of design changes related to the management of severe accidents have already been completed. NB Power committed to reviewing their program and system readiness in light of the events in Japan, and providing a progress report by April 29, 2011.

On April 28, 2011, NB Power confirmed that, based on its preliminary re-examination of the safety cases, the risk related to Point Lepreau Generating Station operation continues to be very low. NB Power has committed to improvement actions that have already been initiated as part of the overall refurbishment project, such as work relating to the new design installations, station system walk-downs and implementation of severe accident management guidelines. Furthermore, NB Power has committed to provide further guidance to ensure adequate cooling of the spent fuel bays, and to enhance existing severe weather emergency procedures in the event of tsunami warning. NB Power will provide a further update by September 15, 2011.

Summary

CNSC staff noted that all licensees are compliant with the regulatory requirements issued under the March 17, 2011 request made under section 12(2) of the GNSCR to provide a detailed review of the lessons learned from the events at Fukushima Daiichi. The April 28, 2011 responses provided by OPG and NB Power give high level assurance that the risks related to the operation of their stations continue to be low. CNSC staff agree that completion of the implementation of severe accidents management programs, which include design modifications such as installation of passive autocatalytic hydrogen recombiners, will further reduce the potential risk.

2.1 Bruce A and Bruce B

2.1.1 Licensing

The Bruce A and B PROLs were renewed in October 2009 for a five-year period (effective from November 1, 2009, until October 31, 2014). Since renewal in 2009, no amendments have been made to either the Bruce A or B PROLs.

Licence amendments

No amendments were made to the Bruce A or Bruce B PROLs during the reporting period.

Revisions to the Licence Conditions Handbook

There were two revisions of Bruce A and B LCHs in 2010 and these revisions were approved by the Director General, Directorate of Power Reactor Regulation. The majority of the changes were administrative in nature, minor changes to compliance dates or clarifications. The most important changes made to the LCHs for both stations during the reporting period are shown in Table 14 and the changes specific to Bruce A or Bruce B only are shown in Tables 15 and 16, respectively.

Table 14: Changes common to both Bruce A and B LCHs

Section	Description of Change	Approval Date	LCH Rev. #	LCH Revision Type (A or T)*
3.3	Added preamble and compliance verification criteria (CVC) for licence condition 3.3 regarding the purpose of the reactor power limits.	August 27, 2010	1	A
5.3	Added Preamble and CVC for licence condition 5.3 regarding changes to the fuel design or composition currently in use.	August 27, 2010	1	A
5.6	Revised dates for the submission of fire protection documentation updates in accordance with CSA N293-07.	August 27, 2010	1	A
6.1	Included CNSC staff acceptance for a concession to use revised operational pressure test requirements.	August 27, 2010	1	T
6.2	Revised the Authorized Inspection Agency section of the CVC regarding CNSC acceptance for a variance or deviation from the requirements of CSA N285.0 or from codes and standards referred to therein.	August 27, 2010	1	A
1.8	Added preamble for licence condition 1.8 regarding adequate regulatory oversight.	August 27, 2010	1	A
1.10	Added preamble and CVC for licence condition 1.10 regarding conflict or inconsistency.	August 27, 2010	1	A
2.1	Removed references to S-99 reporting for limits of hours of work.	August 27, 2010	1	A

Section	Description of Change	Approval Date	LCH Rev. #	LCH Revision Type (A or T)*
2.2	Added preamble and CVC for licence condition 2.2 regarding the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the Act, the regulations, and the licence.	August 27, 2010	1	A
2.4	Added preamble and CVC for licence condition 2.4 regarding certified staff positions.	August 27, 2010	1	A
2.5	Added preamble and CVC for licence condition 2.5 regarding authorities and responsibilities for certified positions.	August 27, 2010	1	A
10.2	Added preamble and CVC for licence condition 10.2 regarding the intent of this licence condition for on-site nuclear response force.	August 27, 2010	1	A
10.3	Added preamble and CVC for licence condition 10.3 regarding the intent of this licence condition for Nuclear Security Officer's medical, physical, and psychological certificates.	August 27, 2010	1	A
5.1	Added references to Bruce A and B final safety analysis report to the document version control table.	August 27, 2010	1	A
2.1	Removed the 4 hour grace period for minimum shift complement violations.	December 23, 2010	2	T
2.3	Revised the preamble and CVC regarding written requalification test requirements	December 23, 2010	2	T
5.5	Revised the dates for the Bruce A probabilistic safety assessments.	December 23, 2010	2	A

* Administrative (A) or Technical (T) revision.

Table 15: Changes to Bruce A LCH

Section	Description of Change	Approval Date	LCH Rev. #	LCH Revision Type (A or T)*
13.2	Added the following Units 1 and 2 return to service documents to document version control (DVC): Bruce Power's integrated implementation plan, *Bruce NGS A Units 1&2 Global Assessment Report and Integrated Implementation Plan*, Rev 00 with updates, and *Bruce Power's Return to Service Plan PMC.6.3.004 Bruce A Return to Service Strategy*, R001.	August 27, 2010	1	A
DVC	Updated the following Bruce A DVC: licence condition 2.1: Bruce Power procedure DIV-OPA-00001, *Station Shift Complement – Bruce A*, Bruce Power procedure BP-PROC-00005, *Limits to Hours of Work*; licence condition 3.1: Bruce Power operating policies and principles BP-OPP-00002, *Operating Policies and Principles – Bruce A*; licence condition 5.1: Bruce Power's program BP-PROG-10.01 *Plant Design Basis Management*	December 23, 2010	2	A

* Administrative (A) or Technical (T) revision.

Table 16: Changes to Bruce B LCH

Section	Description of Change	Approval Date	LCH Rev. #	LCH Revision Type (A or T)*
DVC	Updated the following Bruce B DVC: licence condition 2.1: Bruce Power procedure BP-PROC-00005, *Limits to Hours of Work*; Licence Condition 5.1: Bruce Power's program BP-PROG-10.01 *Plant Design Basis Management*; Licence Condition 13.1: Bruce Power's procedure BP-PROC-00003, *Cobalt Handling*	December 23, 2010	2	A
4.3	Revised the CVC pertaining to the Bruce B main containment structure.	December 23, 2010	2	T
13.1	Revised the Preamble regarding cobalt handling	December 23, 2010	2	A

* Administrative (A) or Technical (T) revision.

In addition to the changes identified in Tables 14 to 16, there were also a number of editorial changes (e.g., corrections to references, alignment with PROLs, updated revision numbers, title and spelling corrections, etc.). The collective changes made to the LCH have not resulted in an unauthorized change of scope and continue to remain within the licensing envelope.

Progress made on licensing commitments

Bruce A environmental assessment program

Bruce Power has implemented several of the activities identified in the *Canadian Environmental Assessment Act* follow-up program, a condition of their licence. These activities included a long-term whitefish monitoring program, which were carried out in collaboration with stakeholders.

The Bruce A Environmental Assessment follow-up monitoring program work continues, according to the plans approved by the CNSC. CNSC staff received the year 2 report (2008) and the year 3 report (2009) in 2010. The Ontario Ministry of Natural Resources has entered the monitoring data on angler bass fishing survey into a specialized database, and has provided the results of its analyses to Bruce Power, for use in designing a replicate survey in 2010.

Aboriginal consultation

With respect to the Bruce A Environmental Assessment program, Bruce Power and the Saugeen Ojibway Nations are cooperating in the development of a research program to address the Nation's concerns related to the whitefish studies. The CNSC continues to address concerns with respect to nuclear projects of the First Nations and Metis peoples in the Bruce region and is seeking to work together with various Aboriginal groups in ensuring the safe and effective regulation of nuclear energy and materials at the Bruce site.

2.1.2 Updates on major projects and initiatives

Life extension of Bruce A units 1 and 2

Refurbishment work continued to progress during 2010. Some of the major work activities for the year included:

- installation of Unit 2 fuel channels (completed)
- installation of Unit 2 feeders (in progress)
- installation of Unit 1 fuel channels (in progress)
- heavy water upgrader placed in service (completed)
- service water systems placed in service (completed)

Bruce Power has a final schedule for Unit 2 fuel loading (a regulatory hold point) in May 2011, and Unit 1 in August 2011.

The remaining hold points for restart are:

- refuelling the reactors
- releasing the reactor guaranteed shutdown state (GSS) and subsequent approach to critical
- increasing the reactor power above 50%

Life extension of Bruce A Units 3 and 4 and Bruce B

Plans for the possible refurbishment of Bruce A Units 3 and 4 and Bruce B Units 5 to 8 are currently under discussion.

Bruce Power is studying the possible replacement of the calandria shield tank assembly (CSTA) for the refurbishment of Units 3 and 4. This would be the first time that the industry will replace the vessel rather than removing individual components as has been done in refurbishments projects to date. The CNSC recognizes the potential safety benefits of the proposed CSTA replacement approach, including reduction in radiation exposures to workers as well as better quality control of CSTA manufacturing. CNSC staff considers the CSTA replacement approach a major change to the earlier proposed refurbishment project, and not a simple clear-cut, like-for-like replacement of one of the components. In this context, CNSC's expectation is that Bruce Power will demonstrate compliance of the proposed approach with the requirements given in Regulatory Document RD-360, *Life Extension of Nuclear Power Plants*. Specifically, Bruce Power should assess the CSTA replacement against modern standards to enable the determination of reasonable and practical modifications that should be made to enhance safety.

2.1.3 Updates on significant regulatory issues

Bruce A Unit 1 alpha contamination event

In November 2009, high airborne radioactivity associated with the restart project activities was detected at Bruce A Unit 1. Analysis confirmed the presence of alpha contamination. Bruce Power reported the event to the CNSC in January 2010, when the preliminary dose estimates for the workers in the area indicated that an action level may have been exceeded. The event was reported to the Commission in CMD 10-M13 in February 2010.

CNSC staff conducted an inspection and concluded that Bruce Power took appropriate actions to contain the contamination and protect the health and safety of workers. Bruce Power continues its follow-up investigation into the event. By the end of the reporting period, the following actions and monitoring results had been reported:

- Bruce Power has set up an extent of condition committee to look at all workers exposed
- Three workers exposed during the alpha event had doses between 5 to 10 mSv; the remaining 554 workers had dose results of less than 5 mSv
- No worker's dose exceeded the annual regulatory dose limit, as per the RPR, of 50 mSv
- Air samplers installed in Units 1 and 2 are monitoring for alpha; all results to date show that there has been no detectable airborne alpha activity outside of containment areas.

The alpha contamination was fully contained within Bruce A Unit 1 and there was no risk to the public or the environment.

Large LOCA margin restoration

Bruce Power successfully implemented the core reorder project in all Bruce B units to allow for power operation upgrade from 90% to 93% full power. The Bruce A and B units will remain derated from full power (Bruce A at 92.5% and Bruce A at 93%) in order to ensure that adequate safety margins are being maintained.

Transport licence application for decommissioned steam generators

The CNSC received a transport licence application from Bruce Power on April 1, 2010, for a proposal to transport 16 decommissioned steam generators by ship through the Great Lakes and St. Lawrence Seaway to Sweden for recycling in the fall of 2010.

Bruce Power's application for a transport licence was subjected to a formal technical review by CNSC staff and the conclusion was reached that there are no significant safety issues associated with the proposed shipment. The application was assessed to have a low risk and normally the decision would have been made by a CNSC Designated Officer. However, in light of the public concern and the value of ensuring both a proper understanding of the scope of the undertaking and the presentation of accurate

information relating to the health, safety and risk, the Designated Officer requested that the Commission review the application at a public hearing. The hearing was held in Ottawa on September 28 to 29, 2010.

On February 4, 2011, CNSC announced the decision to issue a transport licence and certificate to Bruce Power for the transportation of 16 decommissioned steam generators to Sweden. The licence validity period is for one year, February 4, 2011 to February 3, 2012.

Application has been made to the Federal Court of Canada in 2011 for a judicial review of the Commission's decision to grant Bruce Power a licence to transport decommissioned steam generators to Sweden. However, until a decision is made by the Federal Court, the Commission's decision stands and is in effect.

CNSC kept the public well informed of the licence application process through information and news updates and made presentations on this subject to the Owen Sound City Council, the City of Montreal representatives and the Mohawk Council of Akwasasne prior to the Commission decision. After the Commission decision, a Web-broadcasted video technical briefing was made to provide the media with the background information and the scientific data upon which the decision was based.

The conclusion reached is that after extensive assessment and follow-up on the issue of transporting decommissioned steam generators it has been demonstrated that there are no safety concerns.

Licence applications for the transportation of decommissioned NPP components, such as steam generators, from NPPs to other locations for processing may become an emerging issue for the CNSC with future refurbishment projects.

2.2 Darlington

2.2.1 Licensing

The Darlington PROL was renewed in February 2008 for a five-year period (effective from March 1, 2008, until February 28, 2013). Since renewal in 2008, the Darlington PROL has had 14 amendments, five of which were made during the reporting period. The Darlington PROL has not yet been issued under the new format.

Licence amendments

The Darlington operating licence was amended five times during the period January 2010 to April 2011. Details of the amendments are provided in Table 17.

Table 17: Darlington PROL Licence Amendments

PROL # – Effective Date	Amendment Requests
13.10/2013 – June 10, 2010	Replaced Revision 7 of the "Records and Document Control" document N-PROG-AS-0006 with Revision 8 in the Appendix.
	Replaced Revision 12 of the "Nuclear Management System" document N-CHAR-AS-0002 with Revision 13 in Appendix B, Nuclear Management System. N-CHAR-AS-0002 was entitled "Chief Nuclear Expectations" in previous revisions
13.11/2013 – September 10, 2010	Incorporated transitional provisions to Canadian Standards Association (CSA) Standard N285.0-08 and Update No. 12 of licence condition 5.1 and Appendix F, and included Update No. 1 of CSA Standard N290.13-053 in licence condition 7.1.
13.12/2013 – October 22, 2010	Replaced Revision 2 of the "Safety Report: Part 3 – Accident Analysis" with Revision 3 in Appendix A. OPG updates the safety report every three years as required by clause 6.4.4 of CNSC Regulatory Document S-99, *Reporting Requirements for Operating Nuclear Power Plants*
	Replaced Revision 4 of the "Organizational Change Control" document N-PROC-AS-0068 with Revision 5 in Appendix B
	Incorporated revised criteria for firearms qualification of the nuclear response force listed in Appendix B
13.13/2013 – February 7, 2011	Replaced Revision 13 of the "Nuclear Management System" document N-CHAR-AS-0002 with Revision 14 in Appendix B.
	Replaced Revision 8 of the "Station Shift Complement" document D-PROC-OP-0009 with Revision 9 in Appendix B.
	Replaced Revision 4 of the "Darlington Nuclear Generating Station Security Report January 2010" with Revision 5.
13.14/2013 – March 28, 2011	Updated licence condition 3.8 to reference the current revision of the "Nuclear Management System" document.

Revisions to the Licence Conditions Handbook

Darlington does not have a LCH.

Progress made on licensing commitments

Environmental qualification
Licensing requirements on environmental qualification (EQ) have been met. During the execution of the EQ scope of work, substantial EQ modifications were implemented to ensure a sufficiently reliable and qualified line of defence for heat sink following limiting secondary side line breaks that have the potential to lead to harsh environmental conditions in the powerhouse. The single line of defence strategy, which relies on Group 2 systems including the Emergency Service Water (ESW) system as the long-term heat sink assisted by Group 1 power supplies, has been implemented. CNSC has accepted the implementation of this strategy and Darlington meets the applicable safety and regulatory requirements.

Emergency power supply and emergency service water
In 2006, a CNSC Type I inspection of Darlington's emergency power supply and emergency service water systems identified several areas needing improvement. OPG has provided updates in 2007 through 2010 to show their continued progress in addressing these issues. Overall, CNSC staff are satisfied with the information provided.

2.2.2 Updates on major projects and initiatives

Modified 37-element fuel bundle
The modified 37-element (37M) fuel bundle project concept consists of a fuel bundle where the central element (pin) diameter is reduced while keeping other aspects of the fuel bundle design unchanged. The purpose of this modification is to offset the effects of heat transport system aging and restore system design safety margins by improving the fuel dry out power of the current design.

In May 2010, CNSC staff gave the approval for OPG to conduct a demonstration irradiation of 37M fuel bundles subject to prescribed conditions and only loaded into two approved channels. The first channel began fuelling with 37M on May 26, 2010 and the second channel began fuelling on June 29, 2010.

In September 2010, OPG proposed to CNSC staff that dedicated fuelling runs were not necessary to ensure that 37M bundles were loaded into the approved channels. In addition, fuelling runs for the approved channels will take priority in the fuelling schedule and technical staff would monitor the activities of operating personnel during such fuelling runs. CNSC staff approved the proposal in March 2011.

The demonstration irradiation is still ongoing and will require inspection of the fuel bundles and channels after its completion.

Currently, CNSC staff are reviewing the safety case for full core loading of the modified 37M fuel bundles.

Refurbishment/Life extension

Currently, OPG is developing the scope of refurbishment activities for the life extension of the Darlington NPP. The results of the integrated safety review (ISR) and Environmental Assessment, which are conducted pursuant to regulatory requirements will be used as input into the scope. Refurbishment outages are planned to start in late 2016, but this date is subject to operational and regulatory considerations. The refurbished plant could operate until approximately 2050. CNSC staff have accepted the Darlington ISR basis in accordance with RD-360, *Life Extension of Nuclear Power Plants*.

Aging management and periodic inspection program

In January 2010, OPG staff participated in an industry workshop on aging management in concrete containment structures in order to discuss the approach to prepare an AMP for concrete containment structures. In the workshop, CNSC staff presented the draft CNSC Regulatory Document RD-334, *Aging Management for Nuclear Power Plants*, for consideration in developing such a program.

Fuel channel life management project

In 2009, Bruce Power, OPG and AECL jointly initiated a comprehensive R&D project to operate in parallel with the existing COG R&D project. By partnering in this 2.5-year fuel channel life management project (FCLMP), OPG seeks to ensure operational flexibility for its Darlington units - by compiling critical data on aging-related issues that might otherwise limit the life of their fuel channels. During the reporting period, a protocol was signed, governing roles and responsibilities between the licensees and CNSC staff.

This project will address issues affecting life limiting degradation mechanisms in fuel channels (FCs). In particular substantial effort is being spent to ensure that the tight-fitting garter spring spacers in Darlington units can perform their design function, namely remain at the correct axial location and withstand operational loads without losing their integrity.

Feeders

OPG produced submissions providing detailed stress analysis results and a detailed wall thinning assessment report to support the operating life extension of thirteen limiting feeders in Darlington Unit 1. CNSC staff accept the component disposition for 13 Unit 1 outlet feeders and requests conformation of wall thinning rates from a risk-informed method. A large-scale feeder inspection is planned for the spring of 2011 in order to confirm that remaining thickness of feeders in Darlington Unit 1 is sufficient for operation until the next planned outage.

Fuel channels
OPG have implemented an additional tool during their inspection outages to measure the gap between pressure tubes (PTs) and calandria tubes (CTs). This additional information provides an assurance with respect to maintaining an adequate gap in order to avoid PT and CT contact and therefore blister formation.

2.2.3 Updates on significant regulatory issues

Alpha monitoring program
In August 2010, CNSC staff presented their expectations and acceptance criteria for implementation for the radiation protection program requirements for enhanced alpha monitoring based on industry best practice and operating experience.

In December 2010, CNSC staff concluded that OPG has implemented sufficient measured to protect workers against alpha hazards and has demonstrated a commitment to implementing radiation protection program enhancements to monitor and control alpha hazards.

Currently, Darlington continues to implement the enhanced radiation protection program requirements.

Dissimilar metal welds
The dissimilar metal welds between carbon steel and alloy 600 flow device in the Darlington outlet feeders are approaching the high-risk category for susceptibility to primary water stress corrosion cracking. However, the inspection on the dissimilar metal welds in accordance with requirements of CSA N285.4 is difficult to perform because of high dose rates and access limitations.

During 2010 OPG submitted PIP documents for fuel channels, feeders and steam generators in order to provide an update on the management plan specifying the scope of inspection, inspection interval and reporting/disposition requirements, etc, for these components. In this submission, OPG requested exemption from dissimilar metal weld inspections based on the excessive radiological exposure required to execute the inspections in accordance with Clause 3.4.3 of CSA N285.4. Following re-submission, CNSC staff concluded that the preliminary leak-before-break assessment and future work plan were acceptable and has accepted OPG's request to exempt Darlington feeder dissimilar metal welds from periodic inspection.

2.3 Pickering A

2.3.1 Licensing

The Pickering A PROL was renewed in June 2010 for a three-year period (effective from July 1, 2010, until June 30, 2013). Since renewal in 2010, the Pickering A PROL has had one amendment. The 2013 licence renewal will align the Pickering A PROL expiry date with that for the Pickering B PROL.

Licence amendments

One amendment was made to the Pickering A PROL during the period from licence issue, July 1, 2010, to the end of the reporting period for Part 2, April 2011.

This amendment was a change to licence condition 13.2 to reference revised criteria for firearms qualification of the nuclear response force.

Revisions to the Licence Conditions Handbook

The Pickering A LCH was revised four times during the reporting period and these revisions were approved by the CNSC's Director General, Directorate of Power Reactor Regulation. The most important changes made to the LCH for this station are as detailed in Table 18.

Table 18: Changes to Pickering A LCH during the Part 2 Reporting Period

Section	Description of Change	Approval Date	LCH Rev.#	LCH Revision Type (A or T)*
3.1.3	The 2nd paragraph of the CVC was revised to better reflect the current practice. The text in LCH-PNGSA-R000 suggested that the drawing document, NK30-D0A-10200-0001 "Building Development Site Plan" identifies the owner of the land, which is not the case, as it only identifies the parcel of land that is not owned by OPG.	October 19, 2010	1	A
3.3.3	The CVC were revised to reflect the completion of the safe storage project.	October 19, 2010	1	A
3.3.5, 3.3.6, 3.3.7	The wording was changed to avoid any possible confusion since we had been using the word "must" instead of the phrase "expected to" in the CVC. (for sections 3.3.6 and 3.3.7).	October 19, 2010	1	A
3.4.2, 3.4.3	The wording was changed to remove any ambiguity in the CVC.	October 19, 2010	1	A

Section	Description of Change	Approval Date	LCH Rev.#	LCH Revision Type (A or T)*
3.6.2	The CVC were changed to clarify that CNSC expectations regarding applicable CSA standards listed in the preamble (for design modification) do not supersede the requirements in other sections regarding N-285 and N-293.	October 19, 2010	1	T
3.6.6	Appendix D was added to capture any approvals or consents given to the licensee pursuant to a licence condition of the PROL.	October 19, 2010	1	A
3.6.7	It was clarified that the two years frequency for third party audits of one industrial fire brigade fire drill is a CNSC requirements and not a CSA N293-07 requirement (which is three year).	October 19, 2010	1	T
3.7.3, A.1.3	The CVC section was rewritten to discuss the PIP documents clearly and align it wit the structure of the CSA standards. The missing PIP documents were also added to the document version control.	October 19, 2010	1	T
3.7.6	The last paragraph of the CVC was revised to include references to formal correspondence on CNSC expectations for acceptable EQ programs, which were communicated to OPG in 2003 and committed by the OPG in 2004.	October 19, 2010	1	A
3.10.2, 3.10.4	An asterisk was added to the document version control table beside the effective date "TBD" with a footnote at the bottom of the table, explaining that the document is under CNSC staff review and will require a licence amendment before being effective, as some changes are impacting the DRLs listed in Appendix A.3 of the Pickering NGS-A PROL.	October 19, 2010	1	A
4	For clarity purposes, the sources of the definitions in section 4 were restored.	October 19, 2010	1	A
A.1.3	The status of the notification requirement in Appendix A.1.3 was changed from "N" to "P" for the following documents: • N-PROC-MP-0040, "System and Item Classification" • N-PROC-MP-0082, "Design Registration"	October 19, 2010	1	A
3.13.2	The text on S-298 was updated to be consistent with the licence amendment.	November 1, 2010	2	T
D.2	Added the following two consents for licence condition 7.3 that were given by a person authorized by the Commission to the table in Appendix D.2: • CNSC staff approved a request to change the measurement interval (Interval # 4) for the current hydrogen isotope concentration on Unit 1 until February 2013 from the current interval of August 2008 to July 2011 in accordance with clause 12.3.3.2 of CSA N285.4-05 on October 7, 2010.	November 1, 2010	2	A

Section	Description of Change	Approval Date	LCH Rev.#	LCH Revision Type (A or T)*
	• CNSC staff approved a request to use the "Fitness for Service Guidelines for Feeders in CANDU Reactors", COG-JP-4107-V06 Rev. 02 in accordance with clause 13.2.5.1.3 of N285.4-94/05, for a trial period of two years on October 4, 2010.			
1.3.1	Added Appendix D to the list of sections that can be changed by CNSC staff.	January 17, 2011	3	A
3.5.1	Updated the text on RD-310.	January 17, 2011	3	T
3.5.2	Updated the text on S-294.	January 17, 2011	3	T
3.7.3	Updated the text on N287.7.	January 17, 2011	3	T
3.7.3	Updated the text on N285.5.	January 17, 2011	3	T
3.10.2, 3.10.4	Updated the CVC to clarify that modifications to the DRL cannot be implemented until the Commission approves modifications to the DRLs in the licence.	January 17, 2011	3	T
3.11.1	Updated the CVC to incorporate the Commission's Record of Proceedings, Including Reasons for Decision, which specifies under item 209 that the Commission expects to receive the first report on the progress related to this issue by December 2010.	January 17, 2011	3	A
3.13.2	Updated the text on N294-09.	January 17, 2011	3	T
Appendix D.2	Added a CEDA box repair on next Unit 1 outage.	January 17, 2011	3	A
Appendix D.2	Added a non-standard repair on next Unit 4 outage.	January 17, 2011	3	A
3.7.2	Lengthened the time after which OPG needs to submit the final outage report from 90 to 120 days.	March 28, 2011	4	T
Appendix D.1	Added the exemptions listed in section 3.7.3 to Appendix D.1.	March 28, 2011	4	A
3.14.1	Updated section to reflect the implementation of RD-336 and the interim period granted for software updates.	March 28, 2011	4	T
3.3.1	Removed an out-of-date statement on the hours of work limits for casual trade workers.	March 28, 2011	4	A
3.3.2	Updated the text to reflect the current status of the station shift complement activities.	March 28, 2011	4	A
3.4.1	Updated text to reflect the completion of the safe storage project.	March 28, 2011	4	A
3.6.7	Updated text to reflect that compliance with design requirements was achieved in 2010 and compliance with operational requirements will be achieved by 2012.	March 28, 2011	4	A

Section	Description of Change	Approval Date	LCH Rev.#	LCH Revision Type (A or T)*
3.10.1	Updated text to reflect the current status of OPG's work on fish mortality.	March 28, 2011	4	A
3.16.3	Updated to reflect changes that were made to section 3.12.2 in revision 3.	March 28, 2011	4	T
3.7.3	Added a reference to a letter submitted describing corrections to the historical number of body-of-tube scrape channels reported in the PIP documents.	March 28, 2011	4	A

* Administrative (A) or Technical (T) revision.

Progress made on licensing commitments

Vacuum building outage

OPG completed the 2010 VBO which included the vacuum building pressure test, dousing test, pressure relief duct test as well as the inspection of concrete structures and components as per the station periodic inspection program requirements.

2.3.2 Updates on major projects and initiatives

Pickering A Units 2 and 3 safe storage

In November 2005, OPG advised the CNSC of its decision not to return Pickering A Units 2 and 3 to service as previously planned, after its Board of Directors accepted management's recommendation not to proceed with the restart of these units. This decision was made for business reasons. Instead of being returned to operation, Units 2 and 3 were placed in long-term safe storage.

OPG has completed the safe storage project. All systems have been placed in their safe storage states, which were chosen to meet safety, regulatory, environmental and design requirements such that they no longer require operation, maintenance or surveillance.

Units 2 and 3 have been defueled, and the moderator and primary heat transport systems have been drained and dried. The containment boundary was moved to the reactor building bulkheads, systems were electrically de-energized, and pipes were cut and capped.

2.3.3 Updates on significant regulatory issues

Minimum shift complement

The minimum shift complement is the number of appropriately qualified staff that must be on site at all times to operate units safely, including normal operations and accident conditions.

For the past several years, OPG has been undertaking a project to analyze the minimum shift complement requirements of the station taking into consideration the response requirements for events which would affect more than one unit such as a seismic event.

Analysis of the minimum shift complement requirements and an integrated validation exercise were conducted in 2010. As a result, the validated minimum shift complement numbers have been incorporated into an update to P-INS-09100-00003, *Shift Station Complement* and submitted to the CNSC for concurrence.

Fish mortality due to impingement and entrainment

In the 2008 NPP Report, fish mortality due to impingement and entrainment at Pickering A and B was raised as a major issue. OPG is required to reduce impingement mortality by 80–95% by 2012. OPG has installed a barrier net during the summer in front of the water intake. The barrier net is estimated to reduce fish mortality year-round by 70–78%.

OPG will modify the barrier net and continue to monitor performance during 2011.

2.4 Pickering B

2.4.1 Licensing

The Pickering B PROL was renewed in June 2008 for a five-year period (effective from July 1, 2008, until June 30, 2013). Since renewal in 2008, the Pickering B PROL has had 13 amendments, 6 of which were made in the reporting period. The Pickering B PROL has not yet been issued under the new format.

OPG has formally communicated to the CNSC that they plan on extending the station life to approximately 2020. Following this, OPG will begin the following process:

- **Safe storage phase (2020–50):** following shutdown, the units will be placed in safe storage state for a period of approximately 30 years prior to dismantling and decommissioning. OPG has chosen deferment prior to decommissioning to allow for radioactivity to decay; hence, reducing the radiological dose to workers. Pickering B remains subject to its power reactor operating licence that authorizes activities during the transition period from reactor unit shutdown and safe state of storage until it enters the decommissioning phase.
- **Decommissioning phase (2050–60):** the decommissioning of the site will begin in 2050 and is expected to last 10 years, until 2060. A licence to decommission is required prior to commencing the execution of decommissioning activities.
- **Site restoration phase (2060–64):** Following decommissioning, the Pickering final stage, site restoration, will be completed by 2064. A licence to abandon is required post completion of decommissioning/dismantling activities. This will then remove the site from regulatory control and oversight.

Licence amendments

The Pickering B PROL was amended six times from January 2010 to April 2011. The details of the Pickering B operating licence amendments are provided in Table 19.

Table 19: Pickering B PROL Licence Amendments

PROL # – Effective Date	Amendment Requests
08.08/2013 – March 26, 2010	A revision to the Pickering NGS-B *Safety Report, Parts 1 and 2* as part of their obligation under licence condition 1.6.
	An update to the document entitled: *Site Security Taut-Wire Fence Layout and Survey Drawing* applicable to the Pickering NGS-A and Pickering NGS-B site.

PROL # – Effective Date	Amendment Requests
08.09/2013 – June 10, 2010	Changes to licence condition 2.1 to reference a specific section of the organizational change control document. Changes to Appendix B to replace revision 7 of the document, entitled *Records and Document Control*, with revision 8.
	Changes to licence conditions 1.2, 1.3 and 1.4 to modify the title of the document entitled: *Chief Nuclear Officer Expectations* to *Nuclear Management System* and to Appendix B to replace revision 12 of this document with revision 13.
	Changes to Appendix A to replace revision 26 of the document entitled *Building Development Site Plan* with revision 27.
	Changes to Appendix B to replace revision 5 of the document entitled *Pickering Nuclear Generating Station Security Report* with revision 6.
08.10/2013 – September 10, 2010	Change to Appendix I of Pickering B PROL to include transitional provisions related to compliance with Canadian Standards Association (CSA) N285.0-08, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants* and update No.1.
	Change to licence condition 7.1, to include update No. 1 of the CSA N290.13-05, *Environmental Qualification of Equipment for CANDU Nuclear Power Plants.*
08.11/2013 – October 22, 2010	Change to Appendix B, to replace revision 9 of the document entitled: *Consolidated Nuclear Emergency Plan* with revision 10.
	Change to Appendix B, to replace revision 4 of the document entitled: *Organizational Change Control* with revision 5.
	Change to licence condition 10.2 to reference revised criteria for firearms qualification of the nuclear response force.
08.12/2013 – February 07, 2011	An update to licence condition 5.2 to incorporate the revised version of CSA N285.4 (2005), *Periodic Inspection of CANDU Nuclear Power Plant Components* including Update No. 1.
	An update to Appendix B to reflect the most current revision of OPG's nuclear management system document, N-CHAR-AS-0002 R14.
08.11/2013 – March 28, 2011	Updated licence condition 3.8 to reference the current revision of the "Nuclear Management System" document. Amendment to make administrative corrections to the PROL.

Revisions to the Licence Conditions Handbook

Pickering B does not have a LCH.

Progress made on licensing commitments

Continued operation plan

The OPG PROL for the Pickering B Nuclear Generating Station was renewed in June 2008 for a five-year period (PROL 08.00/2013). During the licence renewal hearing, Commission members requested that CNSC staff present, at a public proceeding, a report regarding the end-of-life of Pickering B.

In response to the Commission's request, OPG undertook a regulatory commitment to submit the following, upon further consultation with CNSC staff:

- high-level summary of the Pickering B operations plan, including a Pickering site strategic plan by March 31, 2010
- comprehensive Pickering B operations plan by September 30, 2010
- regular annual updates of the Pickering B operations plan, by December 31 of each year

OPG has provided the commitments and CNSC staff have reviewed the continued operation plan (COP) and concluded that, in general, the COP did not address all CNSC expectations and did not provide the technical basis to support continued operation of Pickering B. Further work has been committed by OPG and annual updates of the COP will be provided. The CNSC staff review of the COP was presented to the Commission on March 31, 2011 in CMD 11-M21.

Fuel channel life management project

In 2009, Bruce Power, OPG and AECL jointly initiated a comprehensive R&D project to operate in parallel with the existing COG R&D project. By partnering in this 2.5-year life management project, OPG seeks to extend the operating life of Pickering B fuel channels to 240,000 effective full-power hours by compiling critical data on aging-related issues that might otherwise limit the life of their fuel channels. The FCLMP is scheduled to be completed by the end of year 2012. CNSC staff reviews and acceptance of the FCLMP results is scheduled for early 2013.

CNSC and industry developed a protocol for the conduct of an R&D FCLMP. This protocol specifies the key R&D activities to be undertaken to assure safe reactor operation for continued operation up to 240,000 effective full-power hours. It also details the administrative process to be used to manage the regulatory interaction and reviews for the FCLMP.

Unit 8 outage

The Unit 8 outage was performed in 2010 which included the pressure test for the reactor building as well as the inspection of concrete structures and components for Unit 8.

Vacuum building outage

As reported in section 2.3.1, OPG completed the 2010 VBO, a common system to both Pickering A and B.

2.4.2 Updates on major projects and initiatives

Refurbishment

On March 31, 2010, OPG formally communicated to the CNSC that the OPG Board of Directors had decided not to refurbish Pickering B and would instead plan for continued operation until approximately 2020. Thus, refurbishment has been terminated and OPG is currently working on the continued operations plan.

2.4.3 Updates on significant regulatory issues

Fish mortality due to impingement and entrainment

In the 2008 NPP Report, fish mortality due to impingement and entrainment at Pickering A and B was raised as a major issue. OPG is required to reduce impingement mortality by 80–95% by 2012. OPG has installed a barrier net during the summer in front of the water intake. The barrier net is estimated to reduce fish mortality year-round by 70–78%.

OPG will modify the barrier net and continue to monitor performance during 2011.

Thermal plume

In response to a CNSC letter of recommendation made in consultation with Environment Canada (EC), OPG undertook a study to assess thermal plume effects on whitefish spawning in 2009 including defining study and site-specific criteria for implementing mitigation measures. The main study report was issued in August 2010. A supplementary report on April 2010 habitat mapping is expected in February 2011. The main study report concluded that the thermal plume presents a potential but small risk to round whitefish consistent with the prediction of non-significant, minor adverse effect from the environmental assessments for the Pickering A return to service and the Pickering B refurbishment project. Given the results of the studies to date, no further risk assessment or management activity was planned by OPG.

A final review of the main study OPG report by CNSC staff is under way, with completion contingent upon receipt of the supplementary report from OPG and another report from EC. The EC report is a summary of their re-analysis of the OPG data. These supplementary reports are expected to be made available in February and March 2011 from OPG and EC, respectively. The results will then need to be shared and discussed among specialist staff of OPG, CNSC, EC, the Ontario Ministry of Natural Resources and the Lake Ontario Fishery Management Agency. CNSC staff plan to consult with EC to define regulatory expectations based upon the determination of the need for further risk assessment or risk management.

The agencies will work with OPG to determine a path forward to resolve the issue of thermal plume effects on round whitefish spawning by year-end 2011.

Minimum shift complement

The minimum shift complement is the number of appropriately qualified staff that must be on site at all times to operate units safely, including normal operations and accident conditions.

For the past several years, OPG has been undertaking a project to analyze the station minimum shift complement requirements taking into consideration the response requirements for events that would affect more than one unit, such as a seismic event.

Analysis of the minimum shift complement requirements and an integrated validation exercise were conducted in 2010. As a result, the validated minimum shift complement numbers will be incorporated into an update to P-INS-09100-00003, *Shift Station Complement* and submitted to the CNSC for concurrence.

2.5 Gentilly-2

2.5.1 Licensing

In April 2010, Hydro-Québec submitted a request to the CNSC Secretariat for renewal of the Gentilly-2 PROL for five years, ending December 31, 2015. This period included a planned station refurbishment scheduled during 2011 and 2012.

In August 2010, Hydro-Québec announced that it was postponing the start of the refurbishment activities to an unspecified date. Hydro-Québec also requested that its waste facility operating licence be combined with its PROL.

Day one hearing for the renewal of the Gentilly-2 licence was held on December 8, 2010 and day two of the hearing took place on April 13 and 14, 2011.

At day one, Hydro-Québec requested the Commission to amend the expiry date of the current operating licence by six months due to the Day two hearing being held in April 2011. The Gentilly-2 PROL was renewed in December 2010 for a six-month period (effective from January 1, 2011, until June 30, 2011). The Gentilly-2 PROL has not yet been issued under the new format.

Licence Amendments

No amendments were made to the Gentilly-2 PROL during the reporting period.

Revisions to the Licence Conditions Handbook

Gentilly-2 does not have a LCH associated with its licence yet. However, in accordance with the evolving licensing process, CNSC staff have developed a draft LCH, to be associated with the next licence expected to be issued for July 1, 2011.

Progress made on licensing commitments

CNSC staff determined, during re-licensing preparation in early 2010 that Hydro-Québec had a large number of outstanding licensing commitments. It became apparent that Gentilly-2 had difficulty in closing open issues. This was linked to a cultural issue with quality management at the plant. During the second half of the year, CNSC staff identified specific closure criteria. Hydro-Québec subsequently established acceptable deadlines and developed solutions (procedures, processes) to meet the closure criteria, and present the proposed solutions for review and acceptance. Hydro-Québec also worked to improve its vision of quality assurance and to improve its corrective action program.

At day one of the renewal hearing held in December 2010, CNSC staff reported to the Commission that Hydro-Québec had met the target completion dates for the closure of open action items.

2.5.2 Updates on major projects and initiatives

Refurbishment project

In August 2010, Hydro-Québec announced that it was postponing the start of the refurbishment activities to an unspecified date.

As part of the refurbishment project, Hydro-Québec submitted the documents related to the integrated safety review (ISR) required as per Regulatory Document RD-360, *Life Extension of Nuclear Power Plants*.

CNSC staff completed a first review of the ISR basis document and concluded that even though the overall approach proposed to conduct the ISR is reasonable, some issues need clarification.

CNSC staff are currently reviewing the 16 safety factor reports. The preliminary review of these documents should be completed by mid-2011. A preliminary review of the deterministic safety analysis safety factor report has been completed and CNSC staff found that an update of the deterministic safety analysis is needed in order to assess the state of the current plant design, the true condition of structures, systems and components (SSCs) and the state it is expected they will be in at the end of the period covered by the ISR (2040).

Hydro-Québec also submitted the global assessment report and the integrated implementation plan during 2010. It should be noted that this integrated plan will include activities that will not necessarily be completed during the refurbishment. Depending upon the results of the ISR, CNSC staff could accept that some work may be completed after the refurbishment activities.

Operation and regulatory plans

As requested by CNSC staff pursuant to the draft Revision 1 of Regulatory Document RD-360, *Life Extension of Nuclear Power Plants*, Hydro-Québec submitted in October 2010 a Gentilly-2 end-of-life operation plan.

In this plan, Hydro-Québec analyzed the end-of-life operating capability of SSCs and demonstrated its knowledge of the SSC limits. Hydro-Québec also described its operational strategy up to the refurbishment, taking into account fuel channels and, in particular, the limits set for the pressure tubes. However, Hydro-Québec recognizes that components will reach other limits before the planned refurbishment. Consequently, Hydro-Québec plans to incorporate maintenance shutdowns in its strategy, to take compensatory actions, to perform field inspections as well as analyses and operations allowing for the replacement or the disposal of components. Hydro-Québec will be

preparing a more detailed modification plan in support of its operational strategy up to the refurbishment.

CNSC staff have conducted a preliminary review of the operations plan, provided comments to the licensee and completed a detailed review of the plan prior to the day two licence renewal hearing. In addition, taking into account the licensee's operations plan, the CNSC is drafting a regulatory plan as a guide on the broad outline of its licensing and compliance regulatory actions during the period leading up to the station refurbishment or the end-of-plant operation.

The most likely time period for the refurbishment to start is during fall 2012. However, the licensee has not committed formally to this period, leaving open the possibility of continuing operation until the end of 2013. Without a firm refurbishment date, CNSC staff will need to ensure that all the analyses required in support of the last months of plant operation before the shutdown for refurbishment are completed.

Based on the operations plan, CNSC has developed a regulatory plan that will be included in the LCH to be released with the next PROL, effective July 1, 2011.

2.5.3 Updates on significant regulatory issues

Alpha monitoring program
In 2010, Hydro-Québec presented its current and planned measures to protect workers against alpha hazards. CNSC staff concluded that the current and planned measures respected best industry practices and operating experience.

Emergency core cooling system valves
An emergency core cooling (ECC) design deficiency that could lead to the two ECC pumps being unavailable was discovered in 2007. Given the impact of this deficiency, Hydro-Québec made a commitment to install two valves in series to improve plant safety. The plant operation plan mentions that Hydro-Québec will replace these valves during a shutdown in 2011. CNSC staff find this objective acceptable.

Operating plan
In order to demonstrate and re-affirm capacity of the reactor to operate safely past 2011, Hydro-Québec was requested to develop and present an operating plan for approval. CNSC staff reviewed the plan, requested a revision and approved the revised plan. The operating plan identifies the analyses and inspections necessary to demonstrate continuous confidence for the next year.

Regulatory surveillance has identified that in particular, life cycle management plans were needed for components such as feeders, steam generators, fuel channels and containment.

Special attention is needed for the containment structure in the longer term since it has been identified that containment concrete suffers from a chemical reaction called "alkali-granulate reaction". CNSC staff will be following the development of the AMP for containment at Gentilly-2 and its implementation.

2.6 Point Lepreau

2.6.1 Licensing

The Point Lepreau PROL 17.11/2012 was renewed in April 2011 for a one-year period (effective April 6, 2011, until June 30, 2012). The Point Lepreau PROL has not yet been issued under the new format.

NB Power had requested in 2010 a renewal of the Point Lepreau PROL 17.11/2011 for one year (effective July 1, 2011, until June 30, 2012) due to the technical issues delaying the refurbishment. NB Power expressed that this renewal would provide the time required for the remaining refurbishment schedule and allow for the completion of licence renewal.

Licence amendments

No amendments were made to the Point Lepreau PROL during the reporting period.

Revisions to the Licence Conditions Handbook

Point Lepreau does not have a LCH.

Progress made on licensing commitments

CNSC staff was requested to provide an annual report on the safety performance of the facility at a Commission public proceeding. An update was included as a portion of the 2009 NPP Report presentation and a further update was recently presented at the January 19, 2011 Commission hearing. A review of the licensing commitments and the current status on refurbishment activities is provided in section 2.6.2, "Updates on Major Projects and Initiatives".

2.6.2 Updates on major projects and initiatives

Point Lepreau refurbishment project

NB Power originally started the reactor refurbishment in April 2008 and planned to be completed by October 2009, with the reactor returned to full power at that time. In October 2010, NB Power released a statement indicating that work on the reactor core now has a planned completion date of May 2012. Once the reactor retube activities are completed, NB Power would then proceed with commissioning activities which are estimated to take approximately four months. Thus, the reactor is not anticipated to be back to full power until fall 2012. NB Power and CNSC staff presented an update on the refurbishment activities to the Commission during the January 19, 2011 hearing.

The current PROL includes licence conditions 12.1 and 12.2, which are directly related to the Point Lepreau refurbishment project. These licence conditions require the licensee to obtain Commission approval before reloading fuel into the reactor core and proceeding with the reactor's restart. Thus, specific CNSC oversight is required prior to proceeding past the following hold points:

- prior to refuelling the reactor
- prior to releasing the reactor guaranteed shutdown state
- prior to exceeding 0.1% reactor power
- prior to exceeding 35% reactor power

Included with licence condition 12.1 is a requirement that the licensee provide a completion assurance report on the installation and commissioning of the refurbishment improvements and modifications listed in the operating licence. NB Power has been submitting these completion assurance reports to the CNSC as required by the PROL.

Based on their current timetable, the fuel reload hearing with the Commission is tentatively scheduled for the late summer or early fall of 2011.

2.6.3 Updates on significant regulatory issues

Fire protection improvements

Design upgrades to the fire protection system to comply with new requirements are proceeding on schedule with 29 of 32 items completed. NB Power is performing a cause analysis to determine and address the underlying causes of the deficiencies with the emergency response team capability. In addition, NB Power will use an industry peer to provide assistance with minimum complement, performance criteria, evaluation tools, and a training program for response team leaders.

Part 3 – Summary and conclusions

This report summarizes the CNSC staff's assessment of the compliance and safety performance of NPP licensees and of the NPP industry as a whole in 2010. The assessment is conducted by rating the performance of each licensee individually and then aggregating the results to give the industry performance for each of the 14 SCAs in the new assessment framework.

In this assessment, the CNSC evaluates how well licensees' programs are meeting regulatory requirements and expectations and are contributing to the overall health, safety and security of Canadians and the environment, in addition to meeting Canada's international commitments on the peaceful use of nuclear energy. The evaluations in this report are based on the consideration of findings from inspections, desktop reviews, event reviews and performance indicators against relevant requirements, expectations and performance objectives.

Based on CNSC staff's assessment summarized in this report, the following general conclusions can be drawn.

3.1 Canadian reactors operated safely

CNSC staff conclude that NPPs in Canada were operated safely during 2010, and that licensees made adequate provisions to protect the health and safety of Canadians and the environment, as well as to ensure that Canada continued to meet its international obligations on the peaceful use of nuclear energy. This conclusion is based on the following observations:

- There were no serious process failures at any NPP.
- No members of the public received a radiation dose in excess of the regulatory limits.
- No workers were confirmed to receive a radiation dose in excess of the regulatory limits.
- The severity of non-radiological injuries to workers was minimal.
- All environmental emissions from the stations were below regulatory limits.
- Licensees complied with their licence conditions concerning Canada's international obligations for the peaceful use of nuclear energy.

In 2010, all NPP operational events that occurred had no or minimal impact on health, safety and the environment and Canada's international obligations concerning the peaceful use of nuclear energy. Licensees properly complied with the requirements to report the events requiring regulatory oversight and conducted (or are conducting) follow-up, including root cause analysis, as necessary.

3.2 Canadian NPP operators maintained their focus on safety

Licensees are required to implement programs that make adequate provisions for the protection of the environment, the health and safety of persons, the maintenance of national security and the measures required to implement Canada's international obligations. This means that licensees are responsible for operating their plants safely.

The 2010 ratings for the SCAs and the integrated plant ratings are presented in Table 20 for all NPPs, along with the industry averages. As can be seen, the integrated plant rating was "fully satisfactory" for Darlington while the ratings were "satisfactory" for the remaining NPPs. This means that the safety and control measures implemented by the licensee were sufficiently effective. In addition, the overall compliance with regulatory requirements and CNSC expectations was satisfactory or higher. There were two "below expectations" ratings observed in 2010, one for radiation protection for Bruce A and one for emergency management and fire protection for Point Lepreau. The licensees are implementing corrective actions.

Table 20: Canadian NPP Safety Performance Ratings for 2010

Safety and Control Area	Bruce		Darlington	Pickering		Gentilly -2	Point Lepreau	Industry Average
	A	B		A	B			
Management system	SA	SA	SA	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA	SA	SA	SA
Operating performance	SA	SA	FS	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA	SA	SA	SA
Fitness for service	SA	SA	FS	SA	SA	SA	SA	SA
Radiation protection	BE	SA	FS	SA	SA	SA	SA	SA
Conventional heath and safety	FS	FS	FS	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA	SA	BE	SA
Integrated plant rating	SA	SA	FS	SA	SA	SA	SA	SA
Waste management*	SA	SA	SA	SA	SA	SA	SA	SA
Security**	**Prescribed. See CMD 11-M46.A for this rating.**							
Safeguards**	SA	SA	SA	SA	SA	SA	SA	SA
Packaging and transport*	SA	SA	SA	SA	SA	SA	SA	SA

* Waste management and packaging and transport were excluded from the integrated plant ratings, as not all NPPs have operating licences in the new format with a LCH that utilizes the new SCA structure.

** Security and safeguards were excluded from the integrated plant rating, recognizing that these areas correspond to important elements of CNSC's mandate that complement—but are separate from—the mandate to protect health, safety, and the environment.

3.3 CNSC staff maintained effective regulatory oversight of NPPs

The CNSC is responsible for, among other activities, regulating the operation of NPPs by issuing licences and ensuring compliance with these licences through verification, enforcement and reporting. During the period of January 2010 to April 2011, CNSC issued renewed operating licences to three stations: Pickering A, Gentilly-2 and Point Lepreau. In addition, the CNSC did many inspections, assessments, reviews and evaluations of licensee programs, processes and safety performance throughout the year. This work varied in complexity and length and consumed the efforts of approximately 226 CNSC staff within the Power Reactor Regulatory Program. This total effort included approximately 38 CNSC employees permanently located at the seven stations who performed on-site inspections, monitor safety performance and provide regulatory support.

A total of over 2,600 findings were analyzed by CNSC staff in the process for determining the SCA ratings. Of this total number of findings, over 99% were assessed as being either of positive, negligible or low safety significance meaning the finding was one that had an effective, insignificant or small negative impact on the assessment of the specific area. The remaining less than 1% of the findings were ones that either had a significant or major negative impact on the assessment of the specific areas. Two SCAs were rated as "below expectations" for Canadian NPPs in 2010 and CNSC staff are monitoring the effectiveness of corrective actions.

Appendix A – Definitions of safety and control areas

The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 safety and control areas (SCAs). These SCAs are further divided into 69 specific areas that define the key components of the SCA. In addition, the 14 SCAs are grouped according to their functional area as management, facility and equipment or core control processes. The functional areas, SCAs and specific areas that make up CNSC safety performance evaluations are given in Table A.1.

Table A.1: The CNSC's Functional Areas, Safety and Control Areas and Specific Areas for Assessing Licensee Safety Performance

Functional Area	Safety and Control Area (SCA)	Specific Area
Management	Management system	Management system (including safety management/quality management oversight)
		Organization
		Organizational/change management
		Internal communications
		Monitoring and review of safety management performance
		Safety culture
	Human performance management	Personnel training
		Personnel certification
		Certification examination and requalification testing
		Work organization and job design
		Human performance programs
		Procedures and job aids
		Fitness for duty
	Operating performance	Conduct of licensed activities
		Outage management performance
		Adequacy of procedures
		Operating experience
		Reporting and trending

Functional Area	Safety and Control Area (SCA)	Specific Area
Facility and equipment	Safety analysis	Deterministic safety analysis
		Robustness analysis for malevolent acts
		Safe operating envelope
		Criticality safety
		Probabilistic safety analysis
	Physical design	Component design
		Equipment qualification
		System design and classification
		Configuration management
		Human factors in design
		Robustness design
		Engineering change control
		Site characterization
	Fitness for service	Maintenance activities
		SSC monitoring
		Equipment fitness for service / equipment performance
		Maintenance work
		Spare parts and procurement
		Identification of systems important to safety
		Specifications of parameters for systems important to safety
		Informing of maintenance program
		Assessment of reliability for systems important to safety
		Periodic inspection of pressure boundary components
		Lifecycle management
		Inspections for balance-of-plant
		Pressure boundary integrity
Core control processes	Radiation protection	Application of ALARA
		Personnel dosimetry
		Contamination control
		Worker dose control
	Conventional health and safety	Compliance with applicable labour code
		Housekeeping/management of hazards
		Accident severity
	Environmental protection	Environmental management system
		Estimated dose to public
		Environmental risk assessment
		Effluent and emissions control (releases)
		Environmental monitoring

Functional Area	Safety and Control Area (SCA)	Specific Area
Core control processes (cont'd)	Emergency management and fire protection	Nuclear emergency management
		Conventional emergency response
		Business continuity
		Fire protection and response
	Waste management	Waste minimization, segregation and characterization
		Waste storage and processing
		Preliminary decommissioning plans
	Security	Facilities and equipment
		Access control
		Training, exercises, and drills
		Nuclear response force
	Safeguards	Safeguards
	Packaging and transport	Packaging and transport

Definitions, specific areas and performance objectives for each SCA are provided below.

1. Management system

The management system SCA covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.

Management system relates to the following specific areas: management system (including safety management/quality management oversight), organization, organizational/change management, internal communications, monitoring and review of safety management performance and safety culture.

Performance objective

There is an effective management system that integrates provisions to address all regulatory and other requirements to enable the licensee to achieve its safety objectives, continuously monitor its performance against those objectives, and maintain a healthy safety culture.

2. Human performance management

The human performance management SCA covers activities that enable effective human performance through the development and implementation of processes that ensure that licensees have sufficient staff in all relevant job areas with the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

Human performance management relates to the following specific areas: personnel training, personnel certification, certification examination and requalification testing, work organization and job design, human performance programs, procedures and job aids, and fitness for duty.

Performance objective

Licensee staff are sufficient in number in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

3. Operating performance

The operating performance SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.

Operating performance relates to the following specific areas: conduct of licensed activity, outage management performance, adequacy of procedures, operating experience (OPEX), and reporting and trending.

Performance objective

Plant operation is safe and secure, with adequate regard for health, safety, security, radiation and environmental protection and international obligations.

4. Safety analysis

The safety analysis SCA includes maintenance of the safety analysis that supports that overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards.

Safety analysis relates to the following specific areas: deterministic safety analysis, robustness analysis for malevolent acts, safe operating envelope, criticality safety, and probabilistic safety analysis.

Performance objective

There is demonstration of the acceptability of the consequences of design basis events, and protective systems can adequately control power, cool the fuel and contain any radioactivity that could be released from the plant.

5. Physical design

The physical design SCA relates to activities that impact on the ability of systems, components and structures to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

Physical design relates to the following specific areas: component design, system design and classification, configuration management, engineering change control, human factors in design, robustness design, site characterization, and equipment qualification.

Performance objective

There is confirmation that systems, structures and components, important to nuclear safety and security, continue to meet their design basis in all operational states until the end of their design life.

6. Fitness for service

The fitness for service SCA covers activities that have an impact on the physical condition of systems, components and structures to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.

Fitness for service relates to the following specific areas: maintenance activities, SSC monitoring, equipment fitness for service/equipment performance, maintenance work, spare parts and procurement, identification of systems important to safety, specification of systems important to safety parameters, informing of maintenance program, assessment of reliability for systems important to safety, periodic inspection of pressure boundary components, life cycle management, inspections of balance-of-plant, and pressure boundary integrity.

Performance objective

Systems, structures and components, the performance of which may affect safety or security, remain available, reliable and effective, and consistent with the design, analysis, and quality control measures.

7. Radiation protection

The radiation protection SCA covers the implementation of a radiation protection program in accordance with the RP Regulations. This program must ensure that contamination and radiation doses received are monitored and controlled

Radiation protection relates to the following specific areas: application of ALARA, personnel dosimetry, worker dose control, and contamination control.

Performance objective

The health and safety of persons inside the facility are protected through the implementation of a radiation protection program that ensures that occupational exposures are below regulatory dose limits and are optimized and maintained ALARA.

8. Conventional health and safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.

Conventional health and safety relates to the following specific areas: compliance with applicable labour code, housekeeping/management of hazards, and accident severity.

Performance objective

Conventional health and safety work practices and conditions achieve a high degree of personnel safety.

9. Environmental protection

The environmental protection SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.

Environmental protection relates to the following specific areas: effluent and emissions control (releases), environmental monitoring, estimated dose to public, environmental risk assessment, and environmental management system.

Performance objective

The environment and the health and safety of persons are protected, by the licensee taking all reasonable precautions, including identifying, controlling, and monitoring the release of radioactive substances and hazardous substances to the environment.

10. Emergency management and fire protection

The emergency management and fire protection SCA covers emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions including any results of exercise participation. This also includes fire protection design, analysis and operating performance.

Emergency management and fire protection relates to the following specific areas: nuclear emergency management, conventional emergency response, business continuity, and fire protection and response.

Performance objective

Adequate provisions are made for preparedness and response capability that would mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of national security.

A comprehensive fire protection program is implemented to minimize the risk to the health and safety of persons and to the environment from fire, through appropriate fire protection system design, fire safety analysis, fire safe operation and fire prevention.

11. Waste management

The waste management SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. Also covers the planning for decommissioning

Waste management relates to the following specific areas: waste minimization, segregation and characterization, waste storage and processing, and preliminary decommissioning plans.

Performance objective

There is full development, implementation, and auditing of a facility- and waste stream-specific waste management program to control and minimize the volume of radioactive waste generated by the licensed activity; waste management is included as a key component of the licensee's corporate and safety culture; and a preliminary decommissioning plan is maintained.

12. Security

The security SCA covers the programs required to implement and support the security requirements stipulated in the regulations, in their licence, in orders, or in expectations for their facility or activity.

Security relates to the following specific areas: facilities and equipment, access control, training, exercises and drills, and nuclear response force.

Performance objective

Loss, theft or sabotage of nuclear material or sabotage of the licensed facility are prevented.

13. Safeguards

The safeguards SCA covers the programs required for the successful implementation of the obligations arising from the Canada/IAEA Safeguards Agreement.

This SCA has only one specific area: safeguards.

Performance objective

The licensee conforms with measures required by the facility to meet Canada's international safeguards obligations through:

- *timely provision of accurate reports and information*
- *provision of access and assistance to IAEA inspectors for verification activities*
- *submission of annual operational information and accurate design information of plant structures, processes and procedures*
- *development and satisfactory implementation of appropriate facility safeguards procedures*
- *demonstration of capability, as confirmed through CNSC on-site evaluations, to meet all requirements in support of physical inventory verifications of nuclear material by the IAEA*

14. Packaging and transport

The packaging and transport SCA covers the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility.

This SCA has only one specific area: packaging and transport.

Performance objective

All shipments leaving the site adhere to the Packaging and Transport of Nuclear Substances Regulations and the Transportation of Dangerous Goods Regulations.

Appendix B – Rating methodology and definitions

Performance ratings used in this report are defined as follows:

Fully satisfactory (FS)
Safety and control measures implemented by the licensee are highly effective. In addition, compliance with regulatory requirements is fully satisfactory and compliance within the SCA or specific area exceeds requirements and CNSC expectations. Overall, compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)
Safety and control measures implemented by the licensee are sufficiently effective. In addition, compliance with regulatory requirements is satisfactory. Compliance within the area meets requirements and CNSC expectations. Any deviation is only minor, and any issues are considered to pose a low risk to the achievement of regulatory objectives and CNSC expectations. Appropriate improvements are planned.

Below expectations (BE)
Safety and control measures implemented by the licensee are marginally ineffective. In addition, compliance with regulatory requirements falls below expectations. Compliance within the area deviates from requirements or CNSC expectations to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee or applicant is taking appropriate corrective action.

Unacceptable (UA)
Safety and control measures implemented by the licensee are significantly ineffective. In addition, compliance with regulatory requirements is unacceptable and is seriously compromised. Compliance within the overall area is significantly below requirements or CNSC expectations, or there is evidence of overall non-compliance. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken, and no alternative plan of action has been provided. Immediate action is required.

Rating methodology

The determination of the integrated plant rating (IPR) begins with an assessment of the specific areas and determining the rating for each one. Specific area ratings for the different stations are based on considerations of individual findings from inspections, event reports and desktop reviews.

As a result of the rating activity, performance ratings are determined for each of the 69 specific areas that make up the 14 SCAs, as given in Appendix A. An algorithm is then applied to determine the individual SCA performance rating for each station, resulting in 14 SCA performance ratings for the 7 Canadian NPPs.

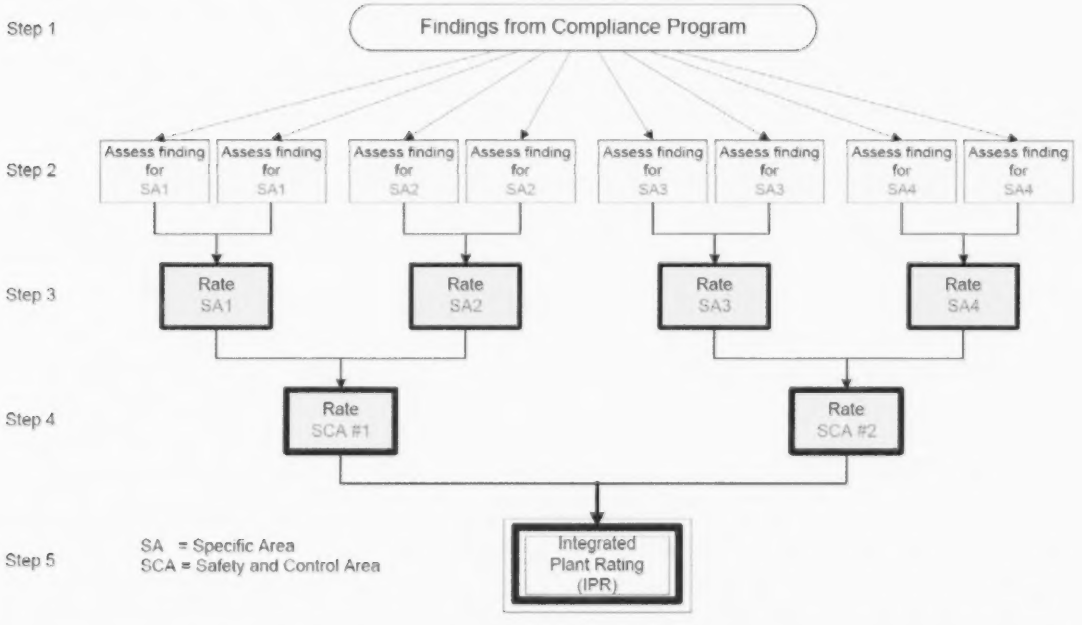
For 2010, equal weights were chosen as a starting point to introduce this methodology. The IPR weighting factors only consider 10 of the 14 SCAs, and exclude the following:

- safeguards
- security
- waste management
- packaging and transport

The SCAs not used in the IPR calculation do not apply to all aspects of plant operation, or complement and are separate from the CNSC mandate to protect health, safety, and the environment. The SCAs not included in the IPR calculation are safeguards, security, waste management and transport.

Figure B.1 depicts the methodology to determine the IPR for each NPP station.

Figure B.1: Ratings for 2010 NPP Report



Steps shown, from top to bottom, are as follows:

Step 1 - Identify the findings
The findings are identified for each specific area using information from a variety of sources, including inspections, event reviews and desktop reviews. Findings are evaluated against a set of compliance criteria developed for each specific area and that measure the degree of conformity with legal requirements.

Step 2 - Assess findings
CNSC staff evaluate the findings against the compliance criteria and assign one of five possible finding assessments, high, medium, low, negligible or positive. The finding assessment category depends on the impact it has, in a negative direction, on the effectiveness of the specific area as given in the manner defined in Table B.1.

Table B.1: Findings Assessment Categories

Findings Category	Definition
High	Major negative impact on effectiveness of safety and control measures in the specific area; evidence of breakdown
Medium	Significant negative impact on effectiveness of safety and control measures in the specific area
Low	Small negative impact on effectiveness of safety and control measures in the specific area
Negligible	Insignificant impact on effectiveness of safety and control measures in the specific area
Positive	Evidence that the specific area is effective

Step 3 - Rate the specific area
CNSC staff consider the relevant findings for the specific area and determine the effectiveness of it using a CNSC-developed guideline set for assessing the findings. The findings are judged in the context of the performance objective for the relevant SCA. The assessed effectiveness categories for all findings of a specific area are converted into a performance rating of UA, BE, SA or FS (category definitions are summarized in Table B.2). The performance ratings definitions are applied for the rating of the specific areas, SCAs and IPRs.

Table B.2: Performance Ratings for Specific Areas, SCAs and IPRs

Rating Category	Definition
FS	Safety and control measures were highly effective
SA	Safety and control measures were sufficiently effective
BE	Safety and control measures were marginally ineffective
UA	Safety and control measures were significantly ineffective

Step 4 - Rate the SCA
The specific area ratings are converted to an integer-based value. Individual specific area ratings are then rolled up through averaging to determine the SCA rating.

Step 5 - Integrated plant rating
The IPR is determined for each station using weighting factors that have been calculated through consideration of the relative importance of the SCA for assessing the safety performance of the plant. Ten of the 14 SCAs only are used in the calculation and the four not used are safeguards, security, waste management and packaging and transport.

It should be noted that the industry average SCA and IPR ratings are determined through arithmetic averaging of the 7 individual ratings for the stations: Bruce A, Bruce B, Darlington, Pickering A, Pickering B, Gentilly-2 and Point Lepreau.

Appendix C – Glossary of Terms

beyond design basis accident (BDBA)
Accident conditions less frequent and more severe than a design basis accident. A BDBA may or may not involve core degradation.

calandria tubes
Tubes that span the calandria and separate the pressure tubes from the moderator. Each calandria tube contains one pressure tube.

Commission
A corporate body of not more than seven members, established under the *Nuclear Safety and Control Act* and appointed by the Governor in Council, to perform the following functions:

- regulate the development, production and use of nuclear energy and the production, possession, use and transport of nuclear substances
- regulate the production, possession and use of prescribed equipment and prescribed information
- implement measures respecting international control of the development, production, transport and use of nuclear energy and nuclear substances, including those respecting the non-proliferation of nuclear weapons and nuclear explosive devices
- disseminate scientific, technical and regulatory information concerning the activities of the CNSC and the effects on the environment and on the health and safety of persons, of the development, production, possession, transport and uses referred to above

Commission Member Document (CMD)
A document prepared for Commission hearings and meetings by CNSC staff, proponents and intervenors. Each CMD is assigned a specific identification number.

derived release limit (DRL)
A limit imposed by the CNSC on the release of a radioactive substance from a licensed nuclear facility, such that compliance with the derived release limit gives reasonable assurance that the regulatory dose limit is not exceeded.

design basis accident (DBA)
Accident conditions against which a nuclear power plant is designed according to established design criteria, and for which the damage to the fuel and the release of radioactive material are kept within authorized limits.

feeder
There are several hundred channels in the reactor that contain fuel. The feeders are pipes attached to each end of the channels used to circulate heavy water coolant from the fuel channels to the steam generators.

guaranteed shutdown state (GSS)
A method for ensuring that a reactor is shut down. It includes adding a substance to the reactor moderator, which absorbs neutrons and removes them from the fission chain reaction, or draining the moderator from the reactor.

International Atomic Energy Agency (IAEA)
The International Atomic Energy Agency (IAEA) is an independent international organization related to the United Nations system. The IAEA, located in Vienna, works with its member states and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies. The IAEA reports annually to the UN General Assembly and, when appropriate, to the Security Council regarding non-compliance by states with their safeguards obligations, as well as on matters relating to international peace and security.

minimum staff (shift) complement
The minimum number of qualified workers who must be present at all times to ensure the safe operation of the nuclear facility and to ensure adequate emergency response capability.

pressure tubes
Tubes that pass through the calandria and contain 12 or 13 fuel bundles. Pressurized heavy water flows through the tubes, cooling the fuel.

root cause analysis
An objective, structured, systematic and comprehensive analysis designed to determine the underlying reason(s) for a situation or event, which is conducted with a level of effort consistent with the safety significance of the event.

safety report
A report, as described in Regulatory Document S-99, *Reporting Requirements for Operating Nuclear Power Plants*, that provides descriptions of the systems, structures, and equipment of a facility, including their design and operating conditions. This includes a final safety analysis report demonstrating the adequacy of the design of the nuclear facility.

serious process failure
A failure of a process system, component or structure:
(a) that leads to a systematic fuel failure or a significant release from the nuclear power plant, or
(b) that could lead to a systematic fuel failure or a significant release in the absence of action by any special safety system

setback
A system designed to automatically reduce reactor power at a slow rate if a problem occurs. The setback system is part of the reactor-regulating system.

special safety system
The shutdown system #1, the shutdown system #2, the containment system, or the emergency core cooling system of a nuclear power plant.

steam generator
A heat exchanger that transfers heat from the heavy water coolant to ordinary water. The ordinary water boils, producing steam to drive the turbine. The steam generator tubes separate the reactor coolant from the rest of the power-generating system.

stepback
A system designed to automatically reduce reactor power at a fast rate if a problem occurs. The stepback system is part of the reactor-regulating system.

systematic approach to training (SAT)
A logical progression from identification of the qualifications and competencies required for performing a job, to the design, development, implementation, and maintenance of the training programs, and to the subsequent evaluation and continuous improvement of these training programs. SAT comprises five phases: analysis, design, development, implementation, and evaluation.

Type I inspection
An audit or evaluation carried out by CNSC staff of a licensee's programs, processes and practices.

Type II inspection
An equipment or system inspection or operating practice assessment carried out by CNSC staff, which includes item-by-item checks and rounds that focus on outputs or performance of licensee programs, processes and practices. Findings play a key role in identifying where a Type I inspection may be required to determine systemic problems in programs, processes or practices.

Appendix D – Acronyms

AECL	Atomic Energy of Canada Limited
ALARA	as low as reasonably achievable
AMP	aging management program
ASR	accident severity rate
BDBA	beyond design basis accident
BOP	balance-of-plant
BWR	boiling water reactor
CM	configuration management
CMD	Commission Member Document
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CRSS	Control Room Shift Supervisor
CSA	Canadian Standards Association
CSI	CANDU safety issue
CSTA	calandria shield tank assembly
CT	calandria tube
CVC	compliance verification criteria
DBA	design basis accident
DRL	derived release limit
DVC	document version control
EC	Environment Canada
ECC	emergency core cooling
EQ	environmental qualification
EPRI	Electric Power Research Institute
ERT	emergency response team
ESW	emergency service water
FC	fuel channel
FCLMP	fuel channel life management project
GAI	generic action item
GNSCR	*General Nuclear Safety and Control Regulations*
GSS	guaranteed shutdown state
HTS	heat transport system
IAEA	International Atomic Energy Agency
I&C	instrumentation and control
IFP	irradiated fuel port
IPR	integrated plant rating
ISR	integrated safety review
IST	industry standard toolset
LCH	licence conditions handbook
LLOCA	large loss of coolant accident
LOCA	loss of coolant accident
LTA	lost time accidents
NB Power	New Brunswick Power
NGS	nuclear generating station

NOP	neutron overpower
NPP	nuclear power plant
NSCA	*Nuclear Safety and Control Act*
OPEX	operating experience
OPG	Ontario Power Generation
OP&Ps	operating policies and principles
PDP	preliminary decommissioning plan
PHWR	pressurized heavy water reactor
PI	performance indicator
PIP	periodic inspection program
PIV	physical inventory verification
PLR	Point Lepreau refurbishment
PMCR	preventive maintenance completion ratio
PROL	power reactor operating licence
PSA	probabilistic safety assessment
PSS	Plant Shift Supervisor
PT	pressure tube
PTNSR	*Packaging and Transport of Nuclear Substances Regulations*
PWR	pressurized water reactor
QA	quality assurance
R&D	research and development
RBSW	reactor building service water
RCA	root cause analysis
RIDM	risk-informed decision making
RO	Reactor Operator
ROP	regional overpower
RP	radiation protection
RPR	*Radiation Protection Regulations*
SAI	safety analysis improvement
SAT	systematic approach to training
SAM	severe accident management
SCA	safety and control area
SHP	Senior Health Physicist
SOE	safe operating envelope
SSCs	structures, systems and components
SWS	service water system
TERP	transportation emergency response program
TRF	tritium removal facility
U0O	Unit 0 Operator
VBO	vacuum building outage
WANO	World Association of Nuclear Operators
WG	working group

Appendix E – Research and development efforts in support of NPP regulation

Introduction

This appendix provides information on research and development (R&D) activities being conducted by the CNSC in support of NPP regulation. It is understood that there are also a number of R&D initiatives being undertaken by AECL and COG in support of the nuclear industry, however, the focus will be on the ones undertaken by CNSC. A brief description of the COG Research and Development program will be given followed by a more detailed report on CNSC initiated activities.

COG R&D Program and the Industry Standard Toolset (IST) Program

The COG R&D Program and the IST Program are sponsored by four Canadian Utilities - Ontario Power Generation, Bruce Power, NB Power and Hydro-Québec; and by Romanian Societatea Nationala Nuclearelectrica S.A. and by Atomic Energy of Canada Limited. As specified in COG-10-9205, *Safety and Licensing R&D Program 2010/2011 Operational Plan*, the COG R&D and IST programs were established to support the safe, reliable and efficient operation of CANDU reactors and are managed under five technical areas:

- fuel channels
- safety and licensing
- health, safety and environment
- chemistry, materials & components
- IST

The CNSC has reviewed various submissions from industry on the work plans, analysis methodology or analysis results for these ongoing safety analysis programs or topics.

CNSC R&D efforts

The CNSC initiated a project in 2007 for the purpose of identifying safety issues associated with the design, analysis and aging management of Canadian CANDU reactors. The identified issues were grouped into three categories, based on risk consideration. This included the generic action items (GAIs) which were re-assigned in the context of all outstanding safety issues. The category 3 GAIs can be found as Table E.1 and the definitions of the risk categories are given in Table E.2.

CANDU safety issues

At the end of 2009, 15 CANDU safety issues (CSIs) were pending resolution. During 2010, after reviewing the submissions from the industry, CNSC staff recommended the closure of the safety issues AA8, "Analysis of moderator temperature predictions" and SS8, "Availability of moderator as heat sink." Of the remaining 13 CSIs pending resolution, 4 are related to large loss of coolant accident (LLOCA). The industry/CNSC joint WG responsible for these issues has released a work plan for resolving them by 2013.

For the nine non-LLOCA issues, a meeting was held in November 2010 involving industry representatives and CNSC staff and industry provided to CNSC information on the resolution activities and their current status. CNSC staff are presently reviewing this information.

The category 3 issues (defined in Table E.2) can be broadly grouped as follows:

Large loss of coolant accident (LLOCA) issues

Four CANDU safety issues are related to LLOCA: two concern fuel behaviour and the other two concern positive void reactivity during LLOCA conditions. The LLOCA design basis event is one of the most difficult accidents to analyze for a CANDU reactor, because many aspects of the reactor behaviour under accident conditions and its computer modeling are subject to considerable uncertainties. A CNSC/industry joint working group was established to resolve these issues and, in 2009, produced a document outlining two possible resolution methods.

Given the timeline associated with completion, CNSC has developed an interim regulatory position in case a research, analytical or plant operation finding, which would have an adverse impact on LLOCA safety margins, emerge during this period. The interim position is consistent with the risk control measures for category 3 CANDU safety issues and will remain in effect until the recommendations of the COG LLOCA working group are accepted by CNSC and are fully implemented by the industry.

GAIs 95G04, 99G02 and 00G01 are included under this safety issue.

Analysis methodology for NOP/ROP

The neutron overpower/regional overpower (NOP/ROP) trip setpoint function is to provide the reactor trip for the analyzed core states prior to fuel dryout. The trip setpoint is designed to prevent any potential fuel damage, primarily for slow loss of regulation events. An inadequate NOP/ROP trip may lead to fuel failures, affecting a significant portion of the fuel channels prior to reactor shutdown on other trips.

CNSC staff agreed with the conclusions of an independent technical panel, and advised licensees that further development work is required on the methodology for its full utilization for licensing applications.

Hydrogen control measures during accidents

Although this has been a long-standing issue, the industry has developed a sufficient understanding of hydrogen behaviour during accidents, and has developed technology to effectively manage both short- and long-term hydrogen production during accidents. As part of closure of GAI 88G02, licensees have committed to installing passive autocatalytic recombiners to improve hydrogen control during design basis accidents.

Licensees are expected to provide the final installation plan and schedule.

Aging of equipment and structures and its impact on safe plant operation

Safety-related functions in nuclear power plants must remain effective throughout the life of the plant. Licensees are expected to have a program in place to prevent, detect and correct significant degradation in the effectiveness, due to the aging of important safety-related functions.

Licensees have AMPs, as well as fitness for service guidelines for life limiting components (i.e., feeders, pressure tubes, steam generator tubes). However, licensee programs for management of aging of other systems and components, have not been implemented systematically as yet, and there are concerns that aging degradation in components other than feeders, pressure tubes, steam generators and reactor power control instrumentation are not adequately managed. In addition, licenses need to make sure that aging effects are taken into account when establishing appropriate operating limits and conditions.

Open design of the balance-of-plant – Steam protection

This issue is applicable to the multi-unit stations. In these stations, steam line breaks and feedwater line breaks are the largest contributors to core damage frequency and large release frequency, accounting for about 70% to 80%. A high energy line break, such as a steam line break or feed water line break, could lead to widespread damage of many electrical cabinets and systems which are not protected enough (or simply open). The turbine hall is an open design with very little steam protection.

To address this issue, licensees need to consider practicable measures to reduce the probability of consequential failures of support systems to control, cool, and contain (e.g., instrument air, electrical, heating ventilation air conditioning, emergency forced air discharge system, air cooling units). Darlington has fully addressed this issue and the CANDU safety issue for Darlington is reclassified to category 2 (defined in Table E.2).

Systematic assessment of high-energy line break effects

On the secondary side, all CANDU NPPs have constructed isolation barriers/engineered restraints and established a second control room to reduce impact from high-energy line breaks. For the primary side, Darlington was the first station that explicitly and fully addressed the requirement for protecting the structures, systems and components (SSCs) from effects of postulated primary heat transport pipe rupture. By constructing isolation barriers/engineered restraints against jet impingement/pipe whip, or being satisfied with the leak-before-break criteria, Darlington has adequately protected the SSCs from the consequences associated with a postulated rupture of high-energy piping. However, the issue of high energy line break on the primary side was not fully addressed in the design stage for other stations. It is important to note that a probabilistic justification was used to minimize the number of locations of high concern.

Licensees need to do an assessment to identify vulnerabilities and implement corrective measures where practicable. In addition, licensees should carry out appropriate inspection and maintenance activities to support the fitness for service status of high energy pipes.

Computer code and plant model validation

Computer code validation measures a computer code's ability to predict plant behaviour. To provide the necessary confidence in the safety analyses being performed, NPP licensees have established specific validation programs for industry standard tool codes.

While CNSC staff note that progress was being made in some areas, existing code validation work does not, in general, comply with the requirements that would allow a full qualification of these codes.

Table E.1: Generic Action Items Open in 2010

GAI	Title	Brief Description	Notes	Expected Closure Date
94G02	Impact of fuel bundle condition on reactor safety	The effects of bundle degradation on reactor safety are not fully known, partially because of limitations of safety analysis methods. It is necessary to conduct an integrated evaluation of information obtained from inspections and examinations, research and safety analyses.	- Closed for all stations, except G-2, prior to 2008. - Closed for G-2 in Feb 2011.	Closed
95G02	Pressure tube failure with consequential loss of moderator	For dual failures involving pressure tube rupture plus loss of emergency core coolant, the moderator may not be available to provide cooling for the fuel channels, due to the possibility of end fitting ejection leading to moderator drainage. Severe accident frequency following this scenario needs to be determined.	- Closed for G-2 in 2010, the remaining work will be tracked under the site-specific action item. - Was closed for all other sites in 2008.	Closed
95G04	Positive void reactivity uncertainty - treatment in large LOCA analysis	Accuracy of void reactivity calculations is a significant safety issue in the analysis of design basis accidents involving channel voiding especially for large LOCAs. Uncertainties and safety margin adequacy are the main questions.	- Closure will depend on the outcome of the industry's current LLOCA activities and CNSC acceptance of the results of those activities.	2013
95G05	Moderator temperature predictions	In some large LOCA scenarios, channels may fail if the moderator temperature is too high to prevent calandria tube external dryout. Computer codes predicting moderator temperatures need to be adequately validated.	- This GAI was followed up through CANDU Safety Issue AA8. - After reviewing the submissions from licensees, CNSC staff recommended the closure of this GAI in Dec 2010.	Closed

GAI	Title	Brief Description	Notes	Expected Closure Date
99G02	Replacement of reactor physics Computer codes used in safety analyses of CANDU reactors	Shortcomings need to be rectified, with respect to inaccurate computer code predictions of key parameters for accident conditions, lack of proper validation and a lag of licensees' methods and codes behind the state of knowledge in this area.	- Linked to GAI 95G04. - Closure will depend on the outcome of the industry's current LLOCA activities and CNSC acceptance of the results of those activities.	2013
00G01	Channel voiding during a LOCA	At issue is the adequate validations of computer codes used for prediction of overpower transients during large LOCA for CANDU reactors with a positive coolant void reactivity coefficient.	- Work in progress: TUF code for OPG and Bruce Power: CNSC staff have completed their review and there are many findings that need to be addressed. The GAI will continue to remain open. - CATHENA Code for Hydro-Québec & NB Power: CNSC staff are assessing Hydro-Québec's submission and anticipate completing the assessment by June 2011.	2013
01G01	Fuel management and surveillance software upgrade	Compliance with reactor physics safety limits defining the safe operating envelope, such as channel and bundle power limits, has enhanced the need for an improved analytical model, validated over a broader range of applications and conditions plus better-defined compliance allowances and more consistent procedures.	- Under review by CNSC staff.	2011

Table E.2: CANDU Safety Issue Risk Categories

Risk Category	Definition
Category 1	Not an issue in Canada. These safety issues have been previously addressed.
Category 2	The issue is a concern in Canada. However, the licensees have appropriate control measures in place to address the issue and to maintain safety margins.
Category 3	The issue is a concern in Canada. Measures are in place to maintain safety margins, but further experiments and/or analyses are required to improve knowledge and understanding of the issue, and to confirm the adequacy of the measures.

Appendix F – 2010 NPP radiation dose information

The following tables provide a five-year trend (2006 to 2010) of annual collective doses to workers at each station. This information has been broken down to show collective doses received during routine operations versus doses received during outages, as well as total collective internal dose, total collective external dose, and total collective effective dose.

It should be noted that the routine and outage dose information is based on estimated doses from electronic dosimetry. The data provided for total internal, external, and collective effective dose represents official dose information.

Column 1 indicates a calendar year of operation.

Column 2 provides the collective dose for routine operations. Variations between years are attributed, in part, to how long the plant operated during each year, as well as typical dose rates associated with the operation of the station.

Column 3 presents the collective dose associated with outages (planned and forced), which includes the dose to all personnel, including contractors. Parameters that affect the dose include the number of outages for the year, the scope and duration of the work, the number of people involved, and the dose rates associated with the outage work.

Columns 4 and 5 provide the total collective dose as a function of internal and external exposure.

Column 6 is the total collective dose, which is the sum of the routine and outage doses or the sum of the internal and external exposure.

The dose data has been broken into routine vs. outage, and internal vs. external, as a means of performance measurement. This data may indicate strengths or weaknesses in a plant's radiation protection program.

It is not appropriate to compare data between the tables, due to differences associated with the individual stations, such as design, age, operation and maintenance.

In 2010, no radiation exposures at any of the stations have been confirmed to exceed regulatory dose limits.

F.1 Annual doses at Bruce A

Bruce A – Units 3 and 4					
Year	Collective Dose		Collective Dose		Total Collective Effective Dose (person-mSv)
	Routine Operations (person-mSv)	Outages (including forced outages) (person-mSv)	Internal Dose (person-mSv)	External Dose (person-mSv)	
2006	439	1,583	491	1,531	2,022
2007	336	4,353	750	3,939	4,689
2008	387	3,853	578	3,662	4,240
2009	341	2,402	244	2,499	2,743
2010	265	3,277	194	3,348	3,542

Bruce A – Units 1 and 2					
Year	Collective Dose		Collective Dose		Total Collective Effective Dose (person-mSv)
	Routine Operations (person-mSv)	Refurbishment Activities (person-mSv)	Internal Dose (person-mSv)	External Dose (person-mSv)	
2006	---**	1,505	214	1,291	1,505
2007	---**	4,331	403	3,928	4,331
2008	---**	3,204	88	3,116	3,204
2009	---**	5,110*	565*	4,545	5,110*
2010	---**	4,123	25	4,098	4,123

* Includes the total internal dose of 512 mSv to 557 workers involved in the alpha event at Unit 1 in November 2009.

** Units being refurbished

There are four units at Bruce A. Units 3 and 4 are in operation, while Units 1 and 2 are under refurbishment.

The majority of the collective dose (mainly external) at Units 3 and 4 can be attributed to outage work. The internal dose at Units 3 and 4 was reduced in 2010 compared with past years due to a number of initiatives implemented by Bruce Power. Examples include the use of new protective equipment (Sperion plastic suits), and optimization of the vault vapour recovery system.

In 2010 no workers at Bruce A Units 3 and 4 received a dose in excess of 20 mSv. The maximum worker effective dose at Units 3 and 4 was 11.65 mSv.

Units 1 and 2 at Bruce A have been under refurbishment since 2005. A significant amount of dose intensive work has been carried out since 2007. Due to a slower place of completion and increased scope items, the overall dose for the project will exceed original estimations.

In 2010, no workers at Bruce A Units 1 and 2 received a dose in excess of 20 mSv. The maximum dose to a worker at Bruce A Restart was 12.92 mSv.

F.2 Annual doses at Bruce B

Bruce B – Units 5 to 8					
Year	Collective Dose		Collective Dose		Total Collective Effective Dose (person-mSv)
	Routine Operations (person-mSv)	Outages (including forced outages) (person-mSv)	Internal Dose (person-mSv)	External Dose (person-mSv)	
2006	573	3,231	277	3,527	3,804
2007	640	3,572	382	3,830	4,212
2008	639	6,013	588	6,064	6,652
2009	570	3,737	333	3,974	4,307
2010	534	3,079	618	2,995	3,613

There were four units in operation at Bruce B during 2010.

There were two major planned outages at Bruce B in 2010 which had a significant impact on the total collective dose for the year. There were also two forced outages that had relatively insignificant dose consequences.

The collective external dose in 2010 was the lowest in the past 5 years. This can be attributed to improvements in outage dose management. However, there was an increase in the annual internal dose at Bruce B due to the moderator spill event at Unit 6, which resulted in 290 person-mSv of internal dose.

The maximum dose to a worker at Bruce B was 25.18 mSv in 2010. This worker was involved in the moderator spill event at Unit 6.

F.3 Annual doses at Darlington

Darlington – Units 1 to 4					
Year	Collective Dose		Collective Dose		Total Collective Effective Dose (person-mSv)
	Routine Operations (person-mSv)	Outages (including forced outages) (person-mSv)	Internal Dose (person-mSv)	External Dose (person-mSv)	
2006	353	2,848	383	2,818	3,201
2007	343	3,764	354	3,753	4,107
2008	220	1,516	139	1,597	1,736
2009	256	2,937	393	2,800	3,193
2010	331	3,373	220	3,484	3,704

There were four units in operation at Darlington during 2010.

There were two planned outages in 2010 (Units 2 and 4) which had a significant impact on the total collective dose for the year. There were also two forced outages (Units 3 and 4) which had a relatively minor impact on collective dose.

The internal dose was reduced in 2010 compared with previous years due to a number of initiatives implemented by Darlington to reduce tritium source term. Examples include the improvement dryer performance to reduce tritium in air concentrations, a reduction in the tritium content in moderator heavy water and a reduction in heavy water leaks.

The external dose increased in 2010 compared with previous two years due to dose during scaffold setup and removal being higher than anticipated during the two planned outages. This was attributed primarily to worker inexperience. A corrective action plan has been put in place to address the dose performance.

In 2010, no workers at Darlington received a dose in excess of 20 mSv. The maximum effective dose received by a worker was 15.74 mSv.

F.4 Annual doses at Pickering A

Pickering A has two reactor units in operation (Units 1 and 4), and two units in safe storage (Units 2 and 3).

Pickering A – Units 1 and 4					
Year	Collective Dose		Collective Dose		Total Collective Effective Dose (person-mSv)
	Routine Operations (person-mSv)	Outages (including forced outages) (person-mSv)	Internal Dose (person-mSv)	External Dose (person-mSv)	
2006	570	2,254	580	2,244	2,824
2007	330	1,816	466	1,680	2,146
2008	536	166	316	386	702
2009	473	1,970	551	1,892	2,443
2010	386	2,688	367	2,707	3,074

The majority of the collective dose at Units 1 and 4 is attributed to outage work performed in 2010.

The collective external dose is higher than target for 2010, due to forced outage dose above targeted contingency, higher than expected dose rates on the Unit 1 reactor face and resulting dose assigned during the P1011 planned outage; and additional scope in both Units 1 and 4 during the P1011 and P1041 outages. Corrective action plans have been put in place to address the dose performance.

The collective internal dose performance is better than target for 2010, due to improved leak management, increased vapour recovery dryer reliability, use of a supplemental dehumidifier during the P1011 outage to reduce ambient tritium concentrations in the Reactor Building and the mandatory use of plastic suits for work in the boiler room for the duration of the P1011 outage. The station's aggressive focus on tritium emission reduction has also contributed to the better than target performance.

Pickering A Safe Storage – Units 2 and 3					
Year	Collective Dose		Collective Dose		Total Collective Effective Dose (person-mSv)
	Routine Operations (person-mSv)	Safe Storage Activities (person-mSv)	Internal Dose (person-mSv)	External Dose (person-mSv)	
2008	---*	78	33	45	78
2009	---*	185	87	97	185
2010	---*	65	16	49	65

* Units in guaranteed shutdown state/safe storage

In 2010, Pickering A transitioned Units 2 and 3 from guaranteed shutdown state to safe storage.

The collective external dose performance for 2010 is better than target. The collective internal dose is also better than target. The project ended in September 2010; no dose has been reported against the Safe Storage project since that time.

In 2010, no workers or contractors at the Pickering site (Units 1 to 8)* received a dose in excess of 20 mSv. The maximum effective dose received by a worker was 13.47 mSv.

* Workers and contractors perform work for both Pickering A and B. The dose data on the maximum effective dose are provided as site data.

F.5 Annual doses at Pickering B

Pickering B – Units 5 to 8					
Year	Collective Dose		Collective Dose		Total Collective Effective Dose (person-mSv)
	Routine Operations (person-mSv)	Outages (including forced outages) (person-mSv)	Internal Dose (person-mSv)	External Dose (person-mSv)	
2006	1,238	3,602	1,048	3,792	4,840
2007	929	2,795	752	2,972	3,724
2008	662	3,292	666	3,288	3,954
2009	573	2,836	532	2,877	3,409
2010	698*	3,238	584	3,352	3,936

* Includes routine operation activities, vacuum building outage (74 p-mSv), and short duration forced outages.

There were four units in operation at Pickering B for 2010.

The majority of the collective dose at Pickering B can be attributed to outage work. There were two planned outages in 2010 (P1072 for a duration of 75 days and a total collective dose of 950 person-mSv; P101 for a duration of 76 days and a total collective dose of 2,288 person-mSv) which had a significant impact on the total collective dose for the year (3,238 person-mSv). There was also the VBO (74 person-mSv), which had a relatively minor impact on collective dose.

The internal dose remained stable in 2010 relative to 2009 with a decreasing trend for the last five years due initiatives implemented by Pickering B to reduce tritium source term activity. This can be attributed to improved drier performance, decreased tritium activity in the moderator and heat transport heavy water and easier access to unit trend and current tritium level data.
In 2010, no workers or contractors at the Pickering site (Units 1 to 8)* received a dose in excess of 20 mSv. The maximum effective dose received by a worker was 13.47 mSv.

* Workers and contractors perform work for both Pickering A and B. The dose data on the maximum effective dose are provided as site data.

F.6 Annual doses at Gentilly-2

Year	Collective Dose		Collective Dose		Total Collective Effective Dose (person-mSv)
	Routine Operations (person-mSv)	Outages (including forced outages) (person-mSv)	Internal Dose (person-mSv)	External Dose (person-mSv)	
2006	322	904	198	1,028	1,226
2007	163	487	115	535	650
2008	153	1,001	140	1,014	1,154
2009	156	521	106	571	677
2010	105	641	121	625	746

Gentilly-2 is a single-unit station.

The majority of the collective dose at Gentilly-2 can be attributed to outage work. The slight increase in the total collective effective dose in 2010 is due to the duration and scope of outage work performed this year.

Since 2006, there has been a decreasing trend in the total collective doses for routine operations. This reduction can be partially attributed to some of ALARA initiatives.

The trend of the total collective internal dose in 2010 is the same as in the past few years. This is due to the efforts made in 2007 to optimize the radiation protection practices related to the wearing of respiratory protection equipment.

In 2010, no worker received a dose greater than 20 mSv. The highest dose received by a worker at the Gentilly-2 is 10.98 mSv.

F.7 Annual doses at Point Lepreau

Year	Collective Dose		Collective Dose		Total Collective Effective Dose (person-mSv)
	Routine Operations (person-mSv)	Outages (including forced outages) (person-mSv)	Internal Dose (person-mSv)	External Dose (person-mSv)	
2006	156	745	131	770	901
2007	129	535	68	596	664
2008*	55	5,943	374	5,624	5,998
2009	Not Applicable	4,082	123	3960	4,082
2010	Not Applicable	1,375	50	1,325	1,375

* Refurbishment began in April 2008

Point Lepreau is a single-unit station.

In 2007, the collective dose was the lowest annual dose recorded since 1991, due to a short planned outage.

In late March 2008, the station was shut down for refurbishment. In 2009 and 2010, the station remained shut down, as the refurbishment outage continued.

Total collective dose during periods of refurbishment (2008 to 2010) is higher than during normal operations due to the nature of the work. The majority of all dismantling work was completed towards the end of 2009.

In 2010, NB Power suspended the installation of the calandria tubes for an approximate 5 month period due to issues with the leak tightness of the rolled joints. NB Power determined that all 380 calandria tubes previously inserted inside the reactor would be removed and replaced to achieve the required calandria tube rolled joint seal integrity. Refurbishment activities to replace the calandria tubes resumed in the fall of 2010.

Doses in 2010 were significantly lower than those in 2008 and 2009 due to:

- The suspension of refurbishment activities; and
- The average daily collective doses from installation activities are significantly lower than dismantling activities (due to reduced dose rates and exposure times).

In 2010, no workers at Point Lepreau received a dose in excess of 20 mSv. The maximum effective dose received by a worker was 11.9 mSv.

F.8 Total annual collective doses for Canadian NPPs

Occupational Dose Summary* from 2006 to 2010

Year	# of Reactors Operating	Collective Dose		Total Collective Effective Dose (person-Sv)	Average Total Collective Effective Dose per Reactor Unit (person-Sv)
		Routine Operations (person-Sv)	Outages (including forced outages) (person-Sv)		
2006	18	3.65	15.17	18.82	1.0
2007	18	2.87	17.32	20.19	1.1
2008	17	2.60	15.84	18.44	1.1
2009	17	2.37	14.40	16.77	1.0
2010	17	2.37	16.30	18.66	1.1

* *Collective dose values excluding refurbishment collective dose from Bruce A Units 1 and 2 and Point Lepreau*

The average total collective effective dose per reactor unit for all operating Canadian NPPs has ranged from 1.0 to 1.1 person-Sv during the past five years.

This data has been graphed in section 1A.7 against international collective radiation dose values and is shown as Figure 8.